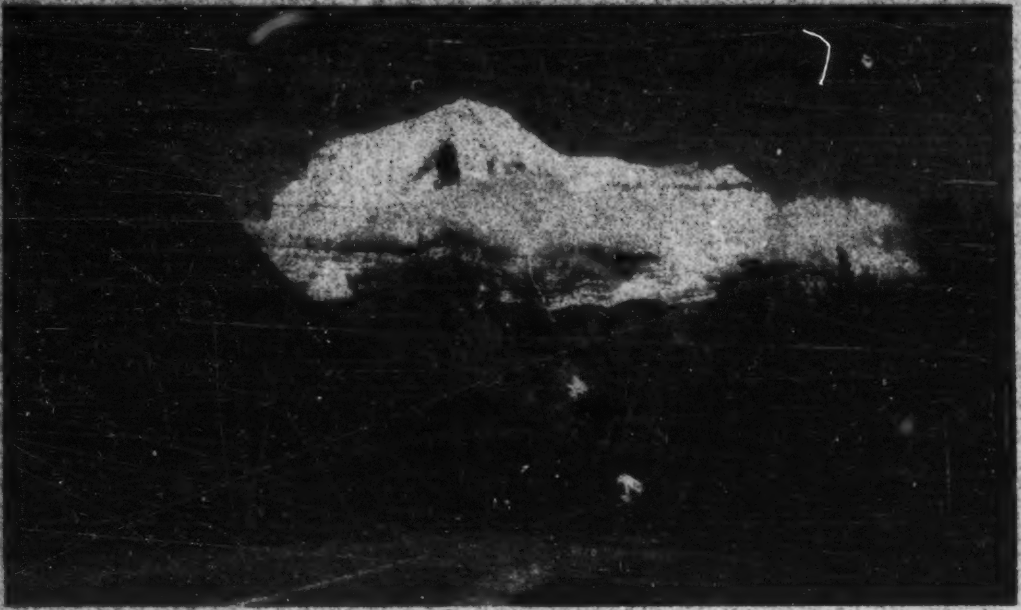
MOUNT ROBSON PROVINCIAL PARK

Ecosystem Management Plan



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MOUNT ROBSON PROVINCIAL PARK ECOSYSTEM MANAGEMENT PLAN

OCCASIONAL PAPER NO. 6 MARCH 2001

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Abstract

The Mount Robson Provincial Park Master Plan (1992) identified the need for the development of vegetation and wildlife management plans. The general ecosystem management goal for Mount Robson Provincial Park was "to provide an area for the conservation of biological diversity of natural forested and non-forested ecosystems, and, as much as possible, to permit their natural ecological processes to occur "unchecked". However, the constraints of critical and important wildlife habitats, habitats of endangered/threatened plants, animals and vegetation communities, fire and beetle epidemics, past management actions, present developments, adjacency issues, and public safety concerns all needed to be addressed within the context of an Ecosystem Management Plan.

To address all these concerns, the provincial park was zoned into four management zones, and objectives and actions were developed for biodiversity conservation, forest fire, forest health and wildlife.

Since the completion of the Ecosystem Management Plan in 1996, the following tasks have been completed:

- installation of two fire weather stations near Park Headquarters and in the Upper Fraser watershed (1997)
- allowing the Brule fire (205 ha) to burn in 1996
- winter habitat assessment for woodland caribou (1998)
- allowing the Moose fire (2500 ha) to burn in 1998
- installation of Sware-flex wildlife reflectors
- completion of a preliminary rare and endangered vascular plant species inventory in 1999
- aerial mountain pine beetle mapping and ground surveys in 1999
- fire management plan in 2000
- Moose River prescribed burn plan in 2000

The calculations in this paper are based on the area of Mount Robson Provincial Park as of 1996 and do not reflect the addition of the 6038-ha area in the Swiftcurrent drainage to the provincial park in 1999. However, many of the maps have been modified to include the Swiftcurrent addition.

In addition, this occasional paper has been edited to reflect BC Parks current policy direction where applicable.

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Part 1 Background and Management Issues

1.0 Introduction

1.1 Mount Robson Provincial Park

Mount Robson Provincial Park (the 'Park') is a Class A provincial park located on the west slope of the Rocky Mountains along the Alberta-British Columbia border, adjacent to Jasper National Park[1] (Figure 1). Established in 1913, the Park covers an area of 219,534 ha and includes variants of the Alpine Tundra (AT), Englemann Spruce-Subalpine Fir (ESSF), Sub-boreal Spruce (SBS), and Interior Cedar Hemlock (ICH) biogeoclimatic zones. Along with Jasper and Banff national parks, Mount Robson Provincial Park has been designated a World Heritage Site by the United Nations Environmental, Scientific, and Cultural Organization.

Overall goals and management objectives for the Park are summarized in the Mount Robson Provincial Park Master Plan (1992). Two major objectives of the park master plan are the development of vegetation and wildlife management plans for the Travel Corridor (Figure 2). The general objective of this project is to prepare an ecosystem management plan for the Park that addresses the objectives and concerns laid out in the park master plan.

Management actions and issues vary considerably within the Park. Except for developed trails, backcountry areas are seldom used and provide important areas for biodiversity conservation and wildlife habitat. Other areas of the Park are intensely used by thousands of visitors every year.

The Travel Corridor (Figure 2) is an area of special management concern for the park. It covers approximately 1% of the Park, and extends from Yellowhead Pass at the provincial boundary to the west boundary of the Park at the confluence of the Robson and Fraser rivers. The Corridor encompasses the Yellowhead Highway (Travel Corridor, Segment 1590), the Canadian National Railway and the Trans-Mountain Oil Pipeline. The Travel Corridor, which serves as a transportation link between British Columbia and Alberta, is the most heavily visited and developed area of the Park.

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[1] In 1999, the provincial government approved an expansion to Mount Robson Provincial Park in the Swift Current area, this plan does not address this area.

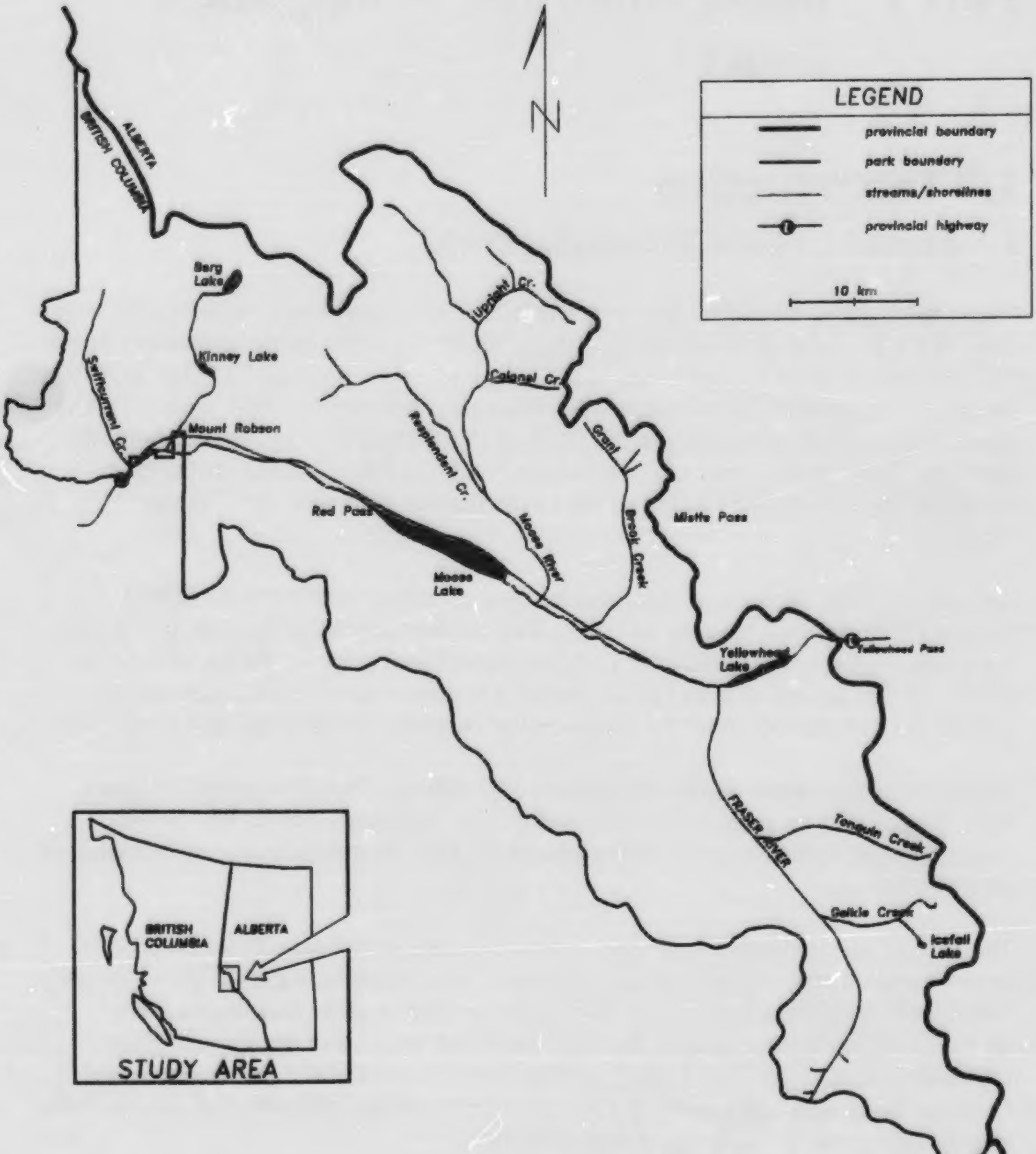
LEGEND
provincial boundary
park boundary
streams/shorelines
provincial highway
10 km
N
ALBERTA
BRITISH COLUMBIA
Berg Lake
Kinney Lake
Swiftcurrent Cr.
Mount Robson
Upright Cr.
Colonel Cr.
Resplendent Cr.
Grant
Red Pass
Moose River
Moose Lake
Brook Creek
Miette Pass
Yellowhead Lake
Yellowhead Pass
FRASER RIVER
Tonquin Creek
Geikie Creek
Icefall Lake
BRITISH COLUMBIA
ALBERTA
STUDY AREA

Figure 1. **Mount Robson Provincial Park showing the main drainages and the Travel Corridor route**

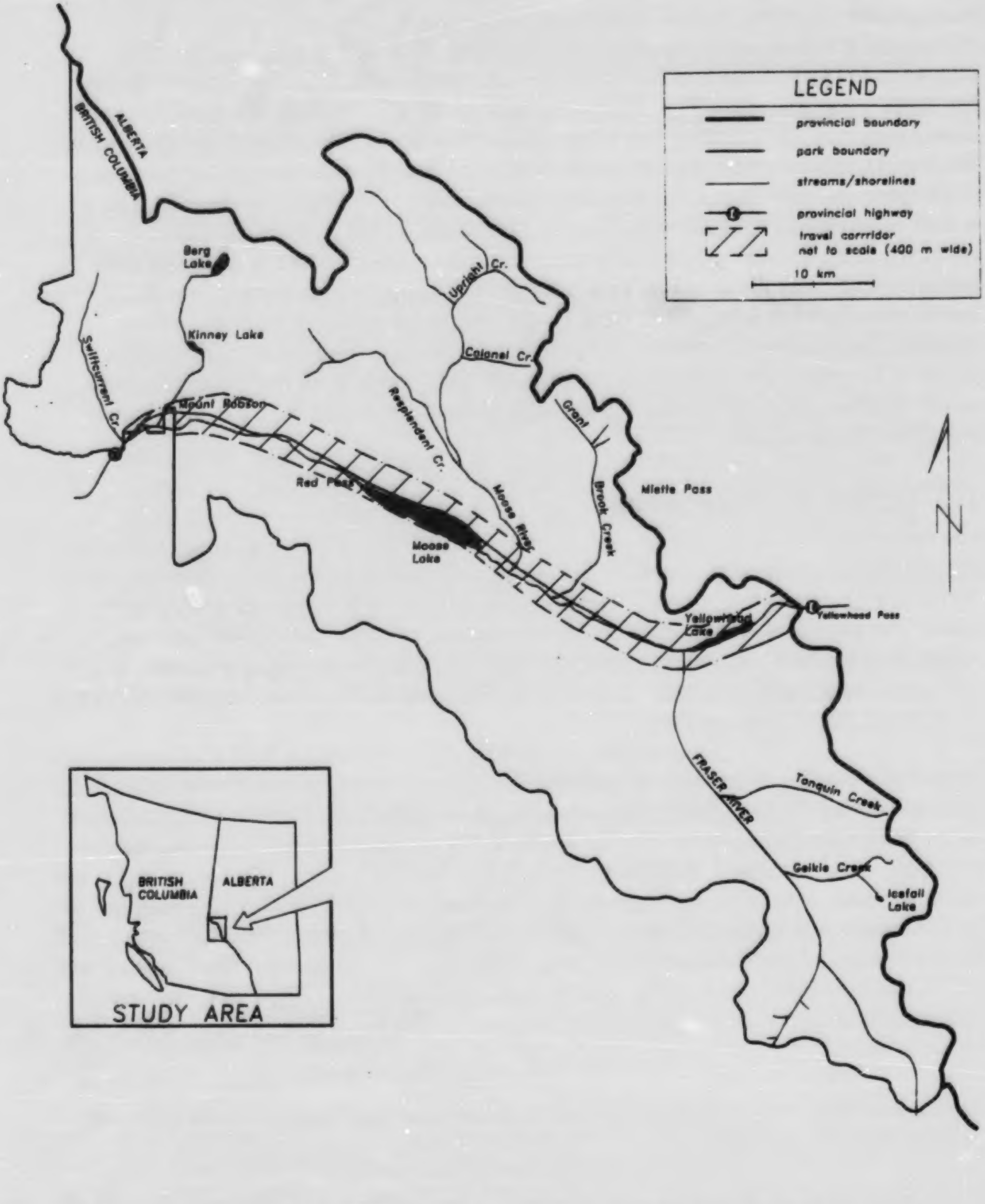
LEGEND
provincial boundary
park boundary
streams/shorelines
provincial highway
travel corrridor
not to scale (400 m wide)
10 km
ALBERTA
BRITISH COLUMBIA
Berg Lake
Kinney Lake
Swiftcurrent Cr.
Mount Robson
Upright Cr.
Colonel Cr.
Resplendent Cr.
Grant
Red Pass
Moose Lake
Moose River
Brook Creek
Miette Pass
Yellowhead Lake
Yellowhead Pass
FRASER RIVER
Tonquin Creek
Geikie Creek
Icefall Lake
N
BRITISH COLUMBIA
ALBERTA
STUDY AREA

Figure 2. Delineation of the Travel Corridor in Mount Robson Provincial Park

Right-of-way development and heavy traffic in the Travel Corridor complicates many Park management objectives, such as wildlife conservation, the maintenance of natural ecosystems and their associated disturbance processes. During the construction of the railway in 1913-1915 much of the Travel Corridor was burned. This, coupled with forest fire suppression since the 1950s, has produced large stands of even-aged forests that are slowly maturing. The resulting loss of age class diversity has reduced wildlife habitat along the Travel Corridor, creating aging stands dominated by lodgepole pine that are becoming increasingly susceptible to large-scale fire and outbreaks of mountain pine beetle. In more remote areas of the Park such events can, in some cases, be left to run their course. However, in the Travel Corridor, large scale disturbance from wildfire or mountain pine beetle outbreak may threaten Park structures and/or human life, and has the potential to spread into adjoining areas. All of these factors complicate a 'no action' management approach, and require that specific management actions be carried out to minimize the potential for undesirable impacts. An assessment of the potential for undesirable impacts within the Park, and management actions to be taken to reduce this risk, are the principle objectives of this project.

1.2 Terms of Reference

The Ecosystem Management Plan for Mount Robson Provincial Park was developed in two phases. Phase 1 consists of summarizing existing information for the Park as a whole, and for the Travel Corridor specifically, and discusses this data with respect to management issues. The general objective of Phase 1 is to collect, synthesize, and analyze existing information for the Park, and thus place management of the Travel Corridor in an ecological context with respect to the rest of the Park, and with regional neighbours, such as the adjacent Jasper National Park.

As part of Phase 2, the information gathered throughout Phase 1, along with the data collected during the 1995 field season, is summarized and synthesized for the development of the Ecosystem Management Plan for the Park. The plan adopts a landscape/ecosystem approach, and pays special attention to the integration of biodiversity, fire, forest health, and wildlife issues, to meet the management objectives outlined in the 1992 master plan for the park. Management approaches put forward will attempt to enhance and work in unison with those presently being developed for adjacent parks and other neighbours. Identification and prioritization of information needs to carry out the plan will be specified, and a suggested implementation schedule for adapting the plan, with interim management approaches, will be included.

More specifically, Part 1: Background, includes a summary and analysis of the following subjects for the entire park:

i) coarse level ecosystem information (ecosections and biogeoclimatic subzones);
ii) biophysical and forest cover information, including a summary of Park ecosystems

and the distribution of Old Growth ecosystems;

iii) fire history, frequency, and potential;
iv) mountain pine beetle history, and outbreak potential;
v) wildlife information, especially as it relates to interactions between wildlife and Travel Corridor traffic; and
vi) the ecological importance and context of the Park within BC Parks, and the Four Mountain Parks.

Part 1 will also include a discussion of the following management issues specific to the Travel Corridor:

i) distribution of habitats that have been altered by human development;
ii) seasonal distribution of wildlife, with special emphasis on large mammals and/or endangered species;
iii) influence of human activities including, but not limited to, transportation rights-of-way (Yellowhead Highway, CNR railway, Trans Mountain Pipeline, BC Tel Fibre optics line), visitor use, fire suppression, introduced species, and commercial activity;
iv) influences outside of the Travel Corridor including, but not restricted to, other Parks, transportation routes, fire suppression, forest insect outbreaks, logging, hunting, trapping, and current or proposed wildlife programs; and
v) the potential impacts of re-establishing fire as a natural disturbance agent on wildlife populations, vegetation and wildlife habitats, and visual quality objectives.

The forest cover database, the TRIM maps, and the biophysical vegetation map (Lea and Maxwell 1993) for the Park will be overlaid to produce the following interpretive maps;

i) vegetation seral stages emphasizing Old Forest distributions;
ii) present fire hazard;
iii) mountain pine beetle hazard;
iv) location of wildlife mortalities;
v) neighbouring stakeholders;
vi) ecosystem management zones; and
vii) wildlife management zones.

1.3 Material and Methods

1.3.1 Resource Material

The primary resource materials are:

i) 1:50 000 scale biophysical vegetation maps for the entire Park (Lea and Maxwell 1993) translated from the original format into PAMAP format;
ii) 1:20 000 scale forest cover maps for the entire Park, also in PAMAP (B.C. Ministry of Forests);

iii) hardcopies of Wildlife Capability and Suitability maps (BC Parks);
iv) a number of reports on Park wildlife and a preliminary wildlife management plan for the Travel Corridor;
v) weather data from stations adjacent to the Park for the assessment of fire weather conditions over the period of record (Canadian Forestry Service);
vi) fire history records (B.C. Ministry of Forests);
vii) forest fire atlases and other management records (B.C. Ministry of Forests);
viii) mountain pine beetle hazard maps and reports (Phero Tech Inc.);
ix) the Mount Robson Park Master Plan (1992);
x) management information from adjacent parks, especially for the Four Mountain Parks system; and
xi) correspondence from meetings between park managers of neighbouring parks.

1.3.2 GIS Integration and Assessment of Vegetation Resources

The forest cover and biophysical vegetation maps were brought together using Geographic Information Systems (GIS) PAMAP for overlaying and processing different themes. The TRIM data for the same map sheets were also integrated into map models, and slope class, aspect class, and elevation class parameters were added to all polygons. Using this baseline data a number of map products (as listed in Section 1.2) were developed.

Databases of the forest cover and biophysical vegetation maps were analyzed to provide summaries of the areal coverage of seral stages (including Old Forest) and biophysical habitat units (BHUs). For the biophysical vegetation maps, most polygons were composites of two or three seral stages or BHUs. Deciles for each BHU were used to calculate areas of the different components of the composite polygons, and then were summed to get total areas for each of the individual BHUs.

Preliminary descriptions of the BHUs for this draft were based on:

1) for forested ecosystems, BHU descriptions provided by BC Environment, and from correlations with the biogeoclimatic site series;
2) for non-forested ecosystems, BHU descriptions provided by BC Environment; and
3) 4 days fieldwork in the Park.

1.3.3 Development of Forest Fire Hazard Ratings

Topographical and biological data generated from the TRIM and forest cover databases were used to develop the fire hazard ratings (Table 1). This forest fire hazard rating system was designed to provide a framework from which to begin understanding the nature and relationships of the forest fuel complex, and provides a basis for developing forest fire management strategies.

Table 1. Terrain/biological variables used for fire hazard assessment and modelling for Mount Robson Provincial Park

	Variable	Scale	Weight
Topography	Slope (average %)	<10	2
		10-20	3
		20-40	4
		>40	5
	Aspect	301°-65° (N)	2
		66°-110° (E)	2
		111°-150° (SE)	4
		151°-240° (S)	5
		241°-300° (W)	4
		All aspects	3
		Levels	3
Biological	Biogeoclimatic Subzone	SBSdh	5
		ESSFmm1	2
		AT	0
	Successional Stage	Pioneer stage 0-20 years old	2
		Pole sapling forest 20-40 years old	8
		Young seral forest 40-80 years old	5
		Mature seral forest 80-140 years old	4
		Old growth >140 years old	3
	Species Composition	Pseudotsuga menziessi, Pinus contorta, Pinus albicaulis >60%	6
		Abies lasiocarpa, Picea engelmannii 40-60%	4
		Deciduous	3
		>60% Deciduous	1
	Crown Closure Class	0	0
		1-35%	1
		36-45%	2
		46-55%	3
		56-65%	4
		>66%	5

Rankings for topographical variables are based on the effects of fire spread for slope and the climatic influence of aspect. Rankings for biogeoclimatic subzones are related to historical fire evidence found in the literature and other studies. Successional stage, species composition, and crown closure class are all stand level variables which describe the fuel complex. The divisions for biogeoclimatic subzones were arbitrary as no other information was available.

Table 2. Fire hazard rating score ranges for stands in Mount Robson Provincial Park

Hazard Class	Score Range
Low	0-6
Moderate	7-13
High	14-20
Extreme	> 20

The fire hazard rating class (Table 2) for a given polygon was based on the sum total of individual highlighted variable rankings, and are summarized for the Park in the appended Fire Hazard Map (Appendix 1). The hazard code represents individual stand susceptibility to fire on a landscape level, relative to other polygons. Some polygons had no forest cover data (e.g., alpine areas, avalanche trenches) and some forested polygons or were missing key variables necessary for the hazard evaluation. For these polygons no hazard was calculated, and these areas are represented in white on the forest fire hazard map. The algorithm used to generate hazard was modified from the Bowron Lake Ecosystem Management Plan (McLennan et al. 1995). For the Park the most important change in the algorithm was the deletion of elevation as a significant variable. The database contained very few elevations below 1000 m. The delineation of elevation above 1000 m was denoted as 1000+ which provided no meaningful distinction between polygons and was therefore not included.

Fire weather data was obtained from six climate stations located in the vicinity of the Park, and which best represented historical fire weather. For each station the daily historical record of 13:00 temperature, precipitation, relative humidity, wind speed and all Canadian Fire Weather Codes and Indices were obtained from the Canadian Forestry Service. The digital file for each station was imported into an Excel 5.0 spreadsheet where variables could be summarized by month and year. The total number of days in which recorded fire weather conditions would promote ignition and spread of fires in the spruce/abies fuel type were compiled by month (June, July, August and September) for each weather station. The fire weather conditions for this analysis were defined as:

1. Fine fuel moisture code (FFMC) $\geq$ 88
2. Duff moisture code (DMC) $\geq$ 40
3. Drought code (DC) $\geq$ 250
4. Initial spread index (ISI) = 8

Summary graphs were also produced for the number of days, by year that the DC was > 500 and for the average August maximum and mean DC by year. Since some stations represented only portions of the complete data record between 1974 and 1994 these results still require some refinement and further analysis to give a more complete picture. This would be accomplished through the acquisition and analysis of future data (i.e., 10 years) which would provide a better baseline from which to develop future prescriptions. Summary graphs for three of the closest weather stations are included in Appendix 2.

1.3.4 Development of Mountain Pine Beetle Hazard Ratings

The susceptibility of lodgepole pine to mountain pine beetle (MPB) has been well characterized by Shore and Safranyik (1992). Their hazard rating system is a stand-based analysis of tree form, elevation and stand density. The system was intended for use in specific stands when complete cruise type data are available to describe the stand characteristics. As a decision- making tool, the hazards can be interpreted as an estimate of the percentage of trees that could be killed during a bark beetle outbreak. The reliability of the mortality estimation is directly related to the accuracy of the data used to describe the stands.

The stand descriptive data used to develop hazard values within the Park were those provided in the forest inventory data files. These forest inventory data files do not contain estimates for tree diameters or stand densities. As these variables are necessary attributes for defining the MPB hazard, according to the Shore and Safranyik system, a suitable source for estimating them was required. The Ministry of Forests' stand table growth and yield reports from forest surveys in similar geographic locations provided the estimates for the range of stem diameters, stocking levels and species distributions within specific stand types.

The MPB hazard, or the percentage of stands which could be killed during an outbreak, is based on how suitable the trees are for attacking beetles and how well the beetles will don once they colonize the stand. The predicted mortality estimate then is a function of the number of susceptible lodgepole pine trees and the number of beetles which could be produced within a stand. The following formula describes how the stand in the Park was developed:

HR = PSP * AF * STD * EF

where; **HR** is the hazard rating or potential percentage mortality following an outbreak;
PSP is the percentage of susceptible pine within a stand;
AF is a stand age factor;
STD is a stand density factor; and
EF is an elevation factor.

AF, STD and **EF** are all factors which will affect the success of bark beetle attacks and their productivity following attack.

The percentage of susceptible pine (PSP) can be calculated with the following formula:

PSP = (BAP/BAT) * 100%

where;
BAP is the basal area of lodgepole pine trees greater than 15 cm diameter
BAT is the basal area of all trees in the stand.

The age class (AF), stand density (STD) and elevation factors (EF) were taken from the following tables which are modified versions of those presented by Shore and Safranyik (1992). The modifications were necessary since Shore and Safranyik (1992) reported on real stand descriptive data whereas the sources used for Mount Robson Provincial Park were confined to interval class estimates for age class, density, diameter and elevation (Table 3).

Table 3. Criteria for determining potential mountain pine beetle productivity in Mount Robson Provincial Park

Age Class	AF
3	0.3
4	0.6
5+	1.0

Density (Stems/ha)	STD
<250	0.1
250-750	0.5
751-1500	1.0
1501-2000	0.8
2001-2500	0.5
>2500	0.1

Elevation (m)	EF
<800	1.0
800-1000	0.7
>1000	0.5

1.3.5 Development of Spruce Beetle Hazard Ratings

The spruce beetle incidence model was developed based on the data of Safranyik (1985). Much of the data required for this model were available in the forest inventory files, however, one key component, diameter, was unavailable, and was omitted from the analysis.

Note that due to data deficiencies and the fact that this model is still in its early stages of development, the incidence ratings produced are only preliminary and should be interpreted with caution. They should serve, however, to help understand the spruce beetle threat in the Park.

The hazard model used was very similar to that of the MPB (section 1.3.5), and the results may be interpreted in the same manner. The following formula was used to describe the stand susceptibility indices and hazard ratings for all spruce stands in the Park:

HR = (PSS * AF * SF * EF)/5.89 * 100%

where; **HR** is the hazard rating or potential percentage mortality following an outbreak;
PSS is the percentage of susceptible spruce within a stand;
AF is the stand age factor;
SF is the stand site quality factor and
EF is an elevation factor.

AF, SF and **EF** are all factors which will affect the success of spruce beetle attacks and their productivity following attack.

PSS, AF, SF and **EF** were determined from Table 4 which were modified from Safranyik (1985).

Table 4. Criteria for determining potential spruce beetle productivity in Mount Robson Provincial Park

% Spruce	PSS	Site Class SF
0-9	0.10	L 0.36
10-19	0.59	P 0.36
20-79	1.21	M 0.88
80-100	1.33	G 1.66

Table 4 continued

Age Class	AF	Elevation (m) EF
<5	0.12	0-1300 1.5
6	0.62	>1300 1.1
>7	1.78	

1.3.6 Assessment of Wildlife in the Park

Biophysical mapping of the Park was completed by the Wildlife Branch of the Ministry of Environment, Lands and Parks in 1993 (Lea and Maxwell 1993). One ecosection, 7 biogeoclimatic zones, and 112 habitat units were identified. Dalziel (1973) identified the location of traditional seasonal home ranges in Mount Robson Provincial Park for deer, moose, elk, caribou, and goats. He identified 7 moose winter ranges, 9 moose summer ranges, 2 deer winter ranges, 2 deer summer ranges, 1 elk winter range, 4 elk summer ranges, 2 caribou winter ranges, and 9 goat ranges in the Park. He also identified 10 salt licks in the Park.

Maps showing the capability of habitats to support wildlife populations have been generated from the biophysical mapping carried out by Lea and Maxwell (1993) for the Park. Suitability indexes were developed by A. Stewart of the Wildlife Branch, Ministry of Environment Lands and Parks, Victoria, BC, for wildlife habitats. Capability indexes indicate the potential of a habitat to support wildlife. Class 1 winter ranges have very high capability to support ungulates in winter. Class 2 ranges have high value, Class 3 have moderate value and Class 4 have low value in winter. For purposes of the vegetation management plan only classes 1W-3W have been considered. Zones with high capability for wildlife can be made more suitable through manipulation of the age class of vegetation. Key ungulate winter range areas along the Travel Corridor were highlighted on the habitat maps, and their locations were used to define special management zones and problem areas with regards to wildlife.

Habitat management objectives and prescriptions for each ecosystem management zone, by habitat unit, were developed using the capability maps, in combination with biophysical habitat maps, seasonal range maps from earlier reports, and roadkill information for Travel Corridor. High kill kilometres were identified through analysis of historical roadkill data.

1.3.7 Ecological Integration of Management Components

An ecosystematic approach to the development of a management plan for the Travel Corridor requires the integration of management components such as wildlife, fire, and forest health, within the Park ecosystem as a whole, and includes specific agents affecting the management plan, e.g., right-of-way considerations, history of fire and pest suppression, and historical land use. To this end the individual biological components are summarized within the context of the biophysical vegetation mapping and an understanding of ecosystem disturbance and succession. Similarly, non-biological influences are integrated into the biophysical summary as they relate to stated concepts of vegetation and ecosystem dynamics. For example, right-of-way corridors result in early-seral examples of specific ecosystem management units, and management impacts and approaches can be developed and applied within this context. The maintenance of high quality wildlife habitat, or the potential for predicting the distributions of introduced plants are examples of management issues that can be dealt with in this ecological context. At an intermediate scale, an understanding of forest succession and species replacement processes provides the basis for active management strategies for allaying fire hazard in aging lodgepole pine stands. At a larger scale, ecological integration of inter-park management issues can be carried out within a regional ecosystem framework, e.g., biogeoclimatic classification. It is the author's belief that such an ecological integration provides a meaningful and useful ecological context for the development of an ecosystem management plan for the Park.

2.0 Ecological Overview

2.1 Physiography and Landforms

The Park is contained entirely within the Main Range of the Continental Ranges and contains the highest peak in the Canadian Rocky Mountains — Mount Robson (3954 metres). This region is largely underlain by sedimentary and metamorphic rocks of late Precambrian and Lower Paleozoic age. Thick limestone and quartzite cliffs of Cambrian age form many of the mountains and gentle, open folds lying between westerly dipping thrust faults. The flat to gently dipping beds, especially of the thick quartzite or limestone formations, produce impressive peaks, of which Mount Robson is an example (Holland 1976).

The Park is bisected by the valley of the Fraser River, and this central valley has one large side valley, that of the Moose River, which flows into the Fraser River from the north. Elevation ranges from about 800 m to the top of Mount Robson at almost 4000 m. Valley bottoms are overlain by glaciofluvial outwash, which has been downcut by the Fraser River in Holocene time. Modern alluvial deposits occur over a small area along rivers. Some areas of organic terrain are present in association with wetlands, especially near Moose Lake. Elevations above about 900 m are either morainal or colluvial blankets and veneers. Much of the upper elevations of the Park are covered by non-vegetated rock and ice.

2.2 Climate

Biogeoclimatic units in the Park (Table 5) show biologically significant changes in regional climatic gradients, and are mapped by comparing the distribution of trees and understory vegetation in climax stands on 'zonal' or average sites (Pojar et al. 1987). The climatic data that characterize the four different biogeoclimatic units in the Park (Table 6) are based on means of 30-year normals from all recording stations in the subzone and are not based on climate measurements within the Park (Reynolds 1993).

Table 5. Synopsis of biogeoclimatic subzones and variants in Mount Robson Provincial Park

Subzone/Variant	Code
Englemann Spruce-Subalpine Fir moist, mild variant	ESSFmm1
Englemann Spruce-Subalpine Fir	ESSFmm2
Englemann Spruce	ESSFmmp
Sub-Boreal Spruce	SBSdh1
Sub-Boreal Spruce	SBSdh2
Interior Cedar-Hemlock	ICHmm
Alpine Tundra	AT

Table 6. Summary of climatic data for biogeoclimatic variants in Mount Robson Provincial Park[1]

Parameter	SBSdh	ICHmm	ESSFmm1	AT
Mean annual precipitation (mm)	6 09.4	645.0	881.0	1031.0
Mean summer precipitation (mm)	237.3	280.5	354.3	417.0
Mean winter precipitation (mm)	351.5			
Mean precipitation of the driest month (mm)	30.4			
Mean precipitation of the wettest month (mm)	72.9			
Mean annual snowfall (mm)	210.5			
Number of months with recorded snow	9.0			
Mean annual temperature (°C)	3.7	4.2	1.0	-1.5
Mean temperature of the coldest month (°C)	-11.0			
Extreme coldest temperature (°C)	-43.2			
Mean temperature of the warmest month (°C)	15.5	14.7	11.0	
Extreme hottest temperature (°C)	36.4			
Number of months with mean temperature >10°C	4.0	3.0	1.0	
Number of months with mean temperature <0°C	5.0			
Number of frost-free days	170.0			

[1] Data are summaries of means of 30-year normals for all recording stations in the variant (Reynolds 1991) and are not based on weather data from within the Park.

The distribution of biogeoclimatic subzones and variants in the Park reflect changes in regional climate along two gradients—from west to east and from low to high elevation Appendix 3). The SBSdh occupies the lowest elevations of the Park, along the central valley of the Fraser River, and is subdivided into the SBSdh1 variant to the west, changing to the SBSdh2 variant west of Moose Lake. In the extreme western portion of the Travel Corridor the SBSdh changes to the ICHmm, as western hemlock and western redcedar begin to occur. Two variants of the ESSFmm subzone occur within the Park; the ESSFmm1 occurs above the ICHmm in the western end of the corridor and the ESSFmm2 above the SBSdh. The ESSF changes to the AT zone across the ESSFmmp, or parkland subzone. The Parkland subzone represents a transitional area between forested and non-forested biogeoclimatic units. Above the ESSFmmp is the AT zone, and represents climates that are sufficiently cool to prevent the survival of trees. Much of the AT is non-vegetated and covered with bare rock and glaciers.

2.3 General Description of the Vegetation

The dry hot Sub-boreal Spruce (SBSdh) subzone occurs throughout the main Fraser River valley of the Park, below 1350 m. Two variants of this subzone are found within the study area. The Sub-Boreal Spruce dry hot variant (SBSdh1) occurs over a small area in the western portion of the Travel Corridor. It is drier and warmer than the SBSdh2 variant within the Park. Southerly aspects are Douglas-fir dominated with little trembling aspen.

The Sub-Boreal Spruce dry hot variant (SBSdh2) occurs throughout the main valley of the Park east of the interior Cedar-Hemlock Zone. Southerly aspects commonly have trembling aspen in early successional stages, leading to Douglas-fir climax communities.

In the SBSdh, the climax tree is hybrid white spruce, with Douglas-fir being a long-lived seral tree. Other seral species include lodgepole pine and trembling aspen. Common understory shrubs are birch-leaved spirea (the scientific names of plant species referred to throughout this document appear in Appendix 4), prickly rose, thimbleberry and soopolallie. Common herbs are bunchberry and twinflower. A moderate to dense moss cover occurs in later successional stages. Steep, dry, southerly aspects have climax forests of Douglas-fir with an understory of saskatoon, soopolallie, Douglas maple and twinflower. Early successional stages may have abundant trembling aspen. Moist, lower slope position sites have lush vegetation trembling aspen, spruce, thimbleberry, red-osier dogwood, devil's club, black twinberry, bunchberry, oak fern and horsetails. There is an extensive area of wetlands east of Moose Lake where a mosaic of shrub-fens, black spruce bogs and shallow open water communities occur.

A small portion of the Robson River, Swift Current Creek and adjacent Fraser valleys is occupied by the Interior Cedar-Hemlock moist mild variant (ICHmm). Climax trees include western redcedar, western hemlock and subalpine fir. Common seral trees are paper birch, trembling aspen, lodgepole pine and Douglas-fir. False azalea, thimbleberry, red-osier dogwood, devil's club and soopolallie are common understory shrubs. Common herbs are bunchberry, oak fern and queen's-cup. The moss layer is quite dense in later successional stages. Douglas-fir dominated communities occur on southerly aspects with an understory of saskatoon, soopolallie, Douglas maple and twinflower. Trembling aspen may be common in early successional stages. In wet, receiving sites western redcedar devil's club communities may occur.

The Engelmann Spruce-Subalpine Fir zone occurs below the Alpine Tundra and above the Sub-Boreal Spruce or Interior Cedar-Hemlock zones. The subalpine zone occurs between approximately 1350 m to 1950 m. Most of the area is dominated by mature coniferous forests over 140 years of age, however, shrub-dominated avalanche chutes are very common on steep sided valley walls. Subalpine meadows, dominated by white mountain heather or forbs and sedges, are common at upper elevations of this zone where continuous forests give way to parkland forests. The ESSF subzone is characteristically forested and is represented by three variants within the Park. The Engelmann Spruce-Subalpine Fir moist mild variant (ESSFmm1) occurs above the Interior Cedar-Hemlock zone in the Rocky Mountain Trench section of the Park. Understory vegetation is dominated by a shrub cover of false azalea, white-flowered rhododendron and black huckleberry. The herb layer commonly has five-leaved bramble, bunchberry and oak fern while the moss layer is usually well represented. Forests consist of lodgepole pine, subalpine fir and Engelmann spruce. Whitebark pine is common on southerly aspects. Douglas-fir may occur at lower elevations of this variant on southerly aspects.

The Engelmann Spruce-Subalpine Fir moist mild variant (ESSFmm2) occurs throughout the major valleys of Mount Robson Park, above the Sub-Boreal Spruce Zone. Understory vegetation is dominated by a shrub cover of false azalea and Labrador tea. The herb layer commonly has bunchberry and dwarf blueberry while the moss layer is well represented. Forests consist of lodgepole pine, subalpine fir and Engelmann spruce. Black spruce is common in lower slope locations, indicating a cold air ponding boreal climatic influence from the east. Whitebark pine (upper elevations) and Douglas-fir (lower elevations) may occur in southerly aspects.

The Engelmann Spruce-Subalpine Fir moist mild parkland (ESSFmmp) occurs just below the Alpine Tundra zone, and is composed of parkland or krummholz trees, usually subalpine fir or Engelmann spruce. The understory is dominated by meadows of mountain heathers or forbs and sedges. This subzone is subjected to an extended period of snow cover and a short growing season.

The Alpine Tundra Zone occurs above the ESSFmmp and is characterized by a mosaic of non-forested communities that reflect the interactive effects of wind and desiccating frost exposure, slope and aspect, soil conditions, and snow accumulations and length of melting. The driest areas are dominated by lichens and sedges. Moist seepage areas with a late snow cover support rich shrub-forb and forb-graminoid communities with often impressive wildflower displays.

2.4 History of Development Within the Park

The Yellowhead Pass has played a major role as a transportation corridor for many years for First Nations, fur traders, explorers, the early tourists, the railway and the Yellowhead Highway. The first inhabitants of this area were the Shuswap who lived between Jasper House and Tete Jaune (BC Parks 1987). It is believed that their diet consisted primarily of salmon, berries, mammals and birds. Their name for Mount Robson was Yuh-Hai-Has-Hun, the "mountain of the spiral road", referring to the layered appearance of the mountain.

The original "Yellowhead" is believed to have been an Iroquois who was brought out from Upper Canada about 1819 to guide Hudson Bay Company traders. This fair-haired Iroquois was called "Tete Jaune", or Yellowhead, and reputedly stashed his furs in the vicinity of what is now called Tete Jaune Cache.

Although the Overlanders were the first Europeans to travel the Yellowhead Pass and the Fraser Valley in the 1860s, it was not until the early 1900s that the Mount Robson area experienced real development. Between the years 1910 and 1914 two railways were constructed through the Yellowhead Pass. Extensive fires associated with railway construction swept through the valley floor destroying forests over a wide area. Although small towns sprung up to house the builders of the railways, only names such as Summit City, Lucerne, Moose City, and Resplendent now remain to mark their existence.

The first successful climb of Mount Robson came in 1913 when the mountaineers of the Alpine Club of Canada were able to travel along the railway grade being constructed and then up the Moose River Valley. This was also the year that the B.C. Government established Mount Robson Provincial Park to protect the wilderness of the Rocky Mountains and special features such as the headwaters of the Fraser River, and Mount Robson Provincial Park, the highest peak in the Canadian Rockies. Since that time the United Nations Environmental, Scientific and Cultural Organization (UNESCO) has designated Mount Robson Provincial Park, along with Jasper and Banff national parks, a World Heritage Site.

During the 1950s the Trans Mountain Oil Pipeline was constructed and in 1987 BC Tel installed a fibre optics line adjacent to the highway grade. Today, the travel corridor is one of the few accesses through the Canadian Rockies linking Alberta and British Columbia. These developments coupled with the servicing of over 500 000 tourists (back and front country users) in 1995, present a conflict with Park management objectives and have resulted in a number of management issues that require attention.

3.0 Vegetation Diversity

This section provides an areal summary and description of the major forested and non-forested ecosystems in the Park. The discussion is organized within the framework of the Biophysical Habitat Unit (BHUs) (Demarchi et al. 1990), where forested BHUs are divided into a number of seral stages that reflect changes in forest structure as stands age. Stand structure and age class criteria for the seral stages are described in Table 7. The areas of the different BHUs by seral stage in the Park are shown in Table 8. BHUs are relatively homogenous with respect to bedrock geology, surficial materials, soils, climate, topography, successional trends of vegetation and potential for animal use (Demarchi et al., 1990). The concept of the BHU falls between that for the site series and site type concepts of the Biogeoclimatic ecosystem Classification (Pojar et al. 1987). Plant communities for the same edatope correspond directly. Codes for each BHU are also given in Table 8, and are used for referring to the BHUs in the discussions that follows. For the purposes of discussion, BHUs are divided into Dry, Mesic, Moist, and Floodplain forest groups, as well as several non-forested groups.

Table 7. Description of the seral stages used in the biophysical vegetation inventory (adapted from Ecosystems Working Group 1993)

Seral Stage	Approximate Age Range (years)	Age Class[1]	Description
1. Shrub Herb (SH)	1-20	1	Early successional stage dominated by herbs and shrubs; some invading or residential trees may be present
2. Pole Sapling (PS)	20-40	2	Trees >10 m tall have overtopped shrub-herb vegetation; stands are typically dense and understory vegetation of low cover in conifer-dominated stands; forest canopy in one continuous layer
3. Young Forest (YF)	40-80	3, 4	Self-thinning has occurred and forest canopy has begun differentiation into dominant, codominant and suppressed trees; understory vegetation often poorly expressed
4. Mature Forest (MF)	80-150	5-7	Trees established after the original disturbance have matured and a second cycle of shade-tolerant trees have become established; main canopy less continuous and understory vegetation may be well developed in places
5. Old Forest (OF)	>150	8, 9	Old, structually complex stands comprised mainly of climax tree species, although seral remnants may be found in the upper canopy; standing and downed snags are common; death of some canopy dominants has created gaps where understory vegetation and coniferous regeneration is well established

[1] Age class as per BC Ministry of Forests forest inventory classes.

Table 8. Subzones, biophysical units, map codes and seral stages of Mount Robson Provincial Park, summarized by the number of polygons and the total area of each successional stage within biophysical habitat units[1]

Subzone or Variant	Biophysical Habitat Unit/Map Code	Seral Stage	No. of Polygons	Area (ha)	Totals (ha)
Dry Forests (Xeric to Submesic Sites)					
SBSdh	Douglas-fir - southerly aspect, deep soil (DSd)	3	14	851.2	
		4	17	1545.4	2396.6
SBSdh	Douglas-fir - saskatoon southerly aspect, shallow soil (DSs)	3	15	990.8	
		4	18	1038.4	2029.2
ICHmm	Douglas-fir - Douglas maple southerly aspect, deep soil (DDd)	3	2	77.3	
		4	8	633.3	
		5	4	15.1	725.7
ICHmm	Douglas-fir - Douglas maple southerly aspect, shallow soil (DDs)	1	2	8.2	
		3	1	6.2	
		4	13	747.0	
		5	2	16.0	777.4
ESSFmm	Black Spruce - terrestrial lichen dry (PS)	3	3	297.7	
		4	5	524.7	
		5	26	1163.8	1986.3
ICHmm	Lodgepole pine - soopolallie fluvial terrace (PS)	3	4	117.5	
		4	6	303.7	481.2
SBSdh	Lodgepole pine - velvet-leaved blueberry fluvial terrace (PV)	1	2	4.9	
		3	18	322.3	
		4	32	1175.5	
		5	1	51.6	1554.3
ESSFmm	Lodgepole pine - dwarf blueberry southerly aspects, deep soil (PB)	1	1	116.1	
		2	4	373.5	
		3	12	604.1	
		4	26	2705.2	
		5	89	8641.9	12 440.7
ESSFmm	Lodgepole pine - terrestrial lichen fluvial terrace (PL)	3	1	38.4	
		4	1	59.1	
		5	2	61.7	159.2
ESSFmm	Whitebark pine - false azalea southerly aspect, shallow soil (WA)	1	5	295.1	
		3	2	78.9	
		4	13	919.3	
		5	38	2358.2	3651.5

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[1] Seral stages are based on descriptions in Table 7. Biophysical habitat mapping by Lea and Maxwell (1993).

Table 8 continued

Subzone or Variant	Biophysical Habitat Unit/Map Code	Seral Stage	No. of Polygons	Area (ha)	Totals (ha)
Dry Forests (Xeric to Submesic Sites) continued					
ESSFmm	Whitebark pine - bracted lousewort southerly aspect, shallow soil (WL)	1	3	181.2	
		2	2	152.8	
		3	13	540.7	
		4	36	2887.3	
		5	47	4637.5	8399.5
	Total area of Dry Forests				**34 601.6**
Mesic Forest (Submesic to Mesic Sites)					
SBSdh	Lodgepole pine - birch-leaved spirea moderate slope (LS)	2	1	55.7	
		3	9	365.1	
		4	19	1139.7	
		5	6	305.6	1886.1
ESSFmm	Lodgepole pine - false azalea moderate slope (PA)	2	3	50.0	
		3	11	555.1	
		4	20	1745.2	
		5	67	7041.5	9391.7
ESSFmm	Lodgepole pine - false azalea cool aspect (PAc)	2	5	565.7	
		3	16	1344.8	
		4	35	3282.2	
		5	142	14 549.1	19 741.8
SBSdh	Spruce - moss cool aspect (SM)	3	6	469.3	
		4	10	725.4	
		5	7	216.3	1411.0
ESSFmm	Engelmann spruce - black huckleberry southerly aspect, deep soil (EH)	1	2	149.1	
		4	5	561.8	
		5	21	2213.3	2924.1
ESSFmm	Subalpine fir - false azalea moderate slope (FA)	1	1	39	
		4	5	239.3	
		5	24	1228.4	1506.7
ESSFmm	Subalpine fir - false azalea cool aspect (FAc)	1	1	16.2	
		3	4	479.9	
		4	15	936.9	
		5	61	5080.3	6513.3
ESSFmm	Subalpine fir - white mountain-heather parkland (FM)	5	130	5343.0	5343.0

Table 8 continued

Subzone or Variant	Biophysical Habitat Unit/Map Code	Seral Stage	No. of Polygons	Area (ha)	Totals (ha)
Mesic Forest (Submesic to Mesic Sites) continued					
ICHmm	Western hemlock - moss cool aspect (HM)	3	2	352.0	
		4	7	517.3	
		5	1	97.5	966.8
ICHmm	Western redcedar - false azalea moderate slope (RA)	2	2	47.4	
		3	1	17.1	
		4	6	525.9	
		5	3	318.4	908.9
	Total area of Mesic Forests				**50 573.4**
Moist Forests (Subhydric to Hydric Sites)					
ESSFmm	Subalpine fir - Labrador tea moist, lower slope (FT)	2	4	45.1	
		3	10	533.6	
		4	34	2665.4	
		5	94	5167.7	8411.9
ESSFmm	Subalpine fire - Sitka valerian parkland (FV)	5	47	1880.3	1880.3
ESSFmm	Subalpine fire - bracted lousewort moist upper elevation (FL)	5	1	37.8	37.8
SBSdh	Trembling aspen - red-osier dogwood moist, lower slope (AD)	3	26	541.7	
		4	32	1270.9	
		5	1	23.7	1836.3
SBSdh	Devil's club - oak fern moist fan (DO)	3	2	57.88	
		4	8	255.2	
		5	2	258.5	571.5
ICHmm	Western redcedar - devil's club fan (RD)	3	2	103.2	
		4	6	490.9	
		5	4	88.7	682.8
ICHmm	Paper birch - red-osier dogwood moist lower slope (BD)	2	1	17.3	
		3	4	347.3	
		4	12	381.4	746.0
ESSF	Black spruce - Labrador tea bog (BT)	0	12	392.6	392.6
	Total area of Moist Forests				**14 559.2**

Table 8 continued

Subzone or Variant	Biophysical Habitat Unit/Map Code	Seral Stage	No. of Polygons	Area (ha)	Totals (ha)
Floodplain Forests (Fluctuating Water Table Sites)					
ICHmm	Spruce - Common horsetail floodplain (SH)	1	1	19.8	
		3	3	34.8	
		4	11	426.9	
		5	1	52.2	
		3	2	14.0	
SBSdh		4	35	445.6	
		5	29	305.0	764.6
ESSFmm	Blacktwinberry - common horsetail floodplain (TH)	2	2	63.1	
		3	1	12.6	
		4	5	125.9	
		5	19	461.7	663.3
	Total area of Floodplain Forests				**1961.6**
Non-Forests-Wetlands					
SBSdh	Willow - sedge fen (WS)	0	24	352.0	
ESSFmm		0	45	1667.3	
ICHmm		0	10	212.4	
	Total Area of Wetlands				2231.7
Non-Forested - Avalanche Chutes					
ESSFmm	Sitka alder - cowparsnip cool aspect avalanche chute (ACc)	0	57	2896.1	
ICHmm		0	5	173.3	
SBSdh		0	1	83.4	3152.8
ESSFmm	Sitka alder - cow parsnip warm aspect avalanche chute (ACw)	0	36	1798.5	
SBSdh		0	1	74.6	1873.1
ESSFmm	Sitka alder - blue wildrye cool aspect avalanche chute (AWc)	0	6	304.8	304.8
ESSFmm	Sitka alder - blue wildrye warm aspect avalanche chute (AWw)	0	19	853.9	
ICHmm		0	2	42.6	
SBSdh		0	1	41.0	937.5
ESSFmm	Subalpine fir warm aspect avalanche chute (Flw)	0	55	2728.5	2728.5
ESSFmm	Subalpine fir cool aspect avalanche chute (Flc)	0	91	3981.3	3981.3
ICHmm	Beaked hazelnut - thimbleberry avalanche chute (HT)	0	3	194.2	194.2
	Total area of Avalanche Chutes				**10 443.7**

Table 8 continued

Subzone or Variant	Biophysical Habitat Unit/Map Code	Seral Stage	No. of Polygons	Area (ha)	Totals (ha)
Non-Forested-Alpine and Subalpine Parkland Communities					
AT	Arctic lupine - Sitka valerian meadow (LV)	0	3	235.3	
ESSFmm		0	1	15.4	250.7
AT	White mountain-avens - moss champion alpine fellfield (MC)	0	9	171.8	171.8
AT	White mountain-heather - alpine pussytoes meadow (MP)	0	451	19 807.7	
ESSFmm		0	93	3497.4	23 305.1
AT	Sedge - alpine pussytoes tundra (SP)	0	4	336.1	
ESSFmm		0	1	21.3	357.4
AT	Sitka valerian - western pasqueflower meadow (VP)	0	101	3249.1	5469.4
ESSFmm		0	74	2220.3	
	Total Area of Alpine/Subalpine Communities				**29 554.4**
Non-Forested - Other Communities					
ESSFmm	Yellow mountain-avens - northern hedysarum pioneer flats (MH)	0	16	836.8	
ICHmm		0	2	278.9	1115.7
ICHmm	Cultivated field (CF)	0	2	64.8	
SBSdh		0	1	29.7	94.5
	Total Area of Other Communities				**1210.2**
Non-Vegetated Polygons					
AT	Deglaciated pioneer (DP)		23	1236.9	
ESSFmm			3	95.1	1332.0
AT	Ice and Permanent snowfields (IC)		130	15 991.7	15 991.7
AT	Rock outcrop, steep cool aspect (ROc)		285	18 156.5	
ESSFmm			88	3377.7	
ICHmm			1	17.9	
SBSdh			5	46.2	21 598.3
AT	Rock outcrop moderate slope (ROm)		142	6337.2	
ESSFmm			13	398.1	6735.3
AT	Rock outcrop steep warm aspect (ROw)		291	17 711.8	
ESSFmm			99	3802.1	
ICHmm			6	194.1	
SBSdh			18	615.9	22 148.9

Table 8 continued

Subzone or Variant	Biophysical Habitat Unit/Map Code	Seral Stage	No. of Polygons	Area (ha)	Totals (ha)
Non-Vegetated Polygons continued					
AT	Talus (TA)		554	31 196.2	
ESSFmm			190	6693.9	
ICHmm			3	31.6	
SBSdh			10	203.9	10 125.6
ESSF	Gravel bar (GB)		3	134.2	134.2
	Total Area of Non-Vegetated Polygons				**78 066.0**

3.1 Forested Ecosystems

3.1.1 Dry Forests

Nine BHUs are included in the Dry Forest group in the Park; the DS, DD, BL, PS, PV, PB, PL, WA and WL (Table 8). These includes sites with xeric to subxeric soil moisture regimes (Pojar et al. 1987) and covers 34 602 ha, which accounts for 37% of the forested area of the Park. Dry forests in the Park can be divided into physiographic groups based on the landforms they occupy. The PL, PV, and PS BHUs are lodgepole pine-dominated ecosystems that develop on coarse glaciofluvial soils on level outwash in the ESSFmm, SBSdh and ICHmm subzones, respectively. PV and PS ecosystems feature lodgepole pine in the tree layer, velvet-leaved blueberry and soopolallie in the shrub layer, and twinflower and bunchberry in the herb layer. Moderate to dense moss cover is also characteristic of these two BHUs. The PL BHU is characterized by lichen cover in the understory, with moderate coverage of common juniper, red bearberry, and bastard toadflax. The BL BHU also occurs on coarse glaciofluvial terraces in the ESSFmm, but black spruce is the dominant tree.

A second group of dry forests occurs on sites with a pronounced southerly aspect and relatively thin soils, which results in a xeric to subxeric soil moisture regime. The DS and DD BHUs occupy morainal and colluvial sites on moderate to steep southerly aspects in the SBSdh and ICHmm respectively. Early seral stages are dominated by trembling aspen which changes to Douglas-fir in the SBSdh, and Douglas-fir with western redcedar in the ICHmm, as succession proceeds. Douglas maple, thimbleberry, and soopolallie coverage is quite high in early seral stages. Their dominance decreases as the stands age. Oxylophytic herbs, such as bunchberry and twinflower, become more abundant, and a moss carpet develops. At higher elevations of the Park, in the ESSFmm, the PB, WA, and WL BHUs occupy dry, south-facing sites. The WA (ESSFmm1) and WL (ESSFmm2) units have abundant whitebark pine in the overstory, with scattered lodgepole pine. Soopolallie, bracted lousewort, and mountain sagewort are common in the understory of WL sites, while false azalea, soopolallie and kinnikinnick are common in the WA BHU. The PB BHU occupies a similar landscape position in the ESSFmm2, but stands are dominated by lodgepole pine, with scattered Englemann spruce and subalpine fir in Mature Forest and Old Forest seral stages. False azalea, dwarf blueberry, and Labrador tea are common shrubs, and occur with bunchberry, and twinflower. Mosses are generally scattered due to dry soils.

3.1.2 Mesic Forests

Eight BHUs occur in the Mesic Forest group. The LS, PA, SM, EH, FA, FM, HM and RA (see Table 8) cover 39 353 ha of the Park. This accounts for about 42% of the forested area. Sites in the group have submesic to mesic soil moisture regimes, and are found on level to steeply sloping morainal terrain. The sites also occur on convex morainal slopes, where the seepage effect is minimal. In the ICHmm, the HM BHU occupies mesic sites on cool aspects. In early seral stages forests are often heavily stocked with western hemlock and western redcedar, so that understory vegetation is poorly developed. In the late seral stages a dense moss carpet covers the forest floor, with scattered herbs such as bunchberry and oak fern, and a few false azalea shrubs. The RA BHU occupies mesic sites on all aspects in the ICHmm, but forests are dominated by western redcedar, with lesser amounts of western hemlock and subalpine fir. Early seral stages may have high coverage of paper birch. Herbs and mosses are similar to the HM.

The distributions of the SM and LS BHUs in the SBSdh are similar to that of the HM and RA in the ICHmm, with the SM occupying mesic sites on cool aspects, and the LS occurring on a range of aspects throughout the subzone. The SM is dominated by Engelmann spruce and subalpine fir with a dense moss layer, scattered herbs and a few shrubs. The LS BHU occurs on well-drained soils with a submesic soil moisture regime. Douglas-fir and lodgepole pine are the dominant trees. Birch-leaved spirea, prickly rose, with some Douglas maple are common shrubs, with bunchberry and twinflower in the herb layer. The moss layer can be moderate to dense.

In the ESSFmm, mesic sites are occupied by the FA and PA BHUs. The FA occurs on moderate to gentle slopes of all aspects, and features a succession where lodgepole pine is replaced by forests dominated by subalpine fir and Englemann spruce. False azalea, white-flowered rhododendron, and five leaved bramble are common, with lesser occurrence of black huckleberry and black gooseberry. Moss coverage is moderate to dense. The PA BHU is the ESSFmm counterpart of the LS in the SBSdh, with lodgepole pine abundant in all seral stages. In the PA the Old Forest sere is dominated by Englemann spruce and subalpine fir, with false azalea, bunchberry, few-flowered wintergreen, and a dense moss carpet. Understory plants in the PA include false azalea, white-flowered rhododendron, five-leaved bramble, and bunchberry, with a moderate to dense moss layer. At the highest elevations of the ESSFmm, parkland-like ecosystems on mesic sites are represented by the FM BHU. These ecosystems have Englemann spruce and subalpine fir in the tree layer, with pink and white mountain heather in the understory. They are transitional to the ESSFmmp.

3.1.3 Moist Forests

The eight BHUs in the Moist Forest group include the FT, FV, FL, AD, DO, RD, BC and BT (see Table 8), and have soil moisture regimes that range from subhygric to subhydric. The Moist Forest group covers a total of about 18 000 ha, representing about 20% of the forested area of the Park. Moist Forest sites are often highly productive due to subsoil seepage, or because of seasonal or permanent water tables within or near the rooting zone. Where drainage is impeded organic soils may develop and site productivity can be considerably reduced.

In the ICHmm, the Moist Forest group is represented by the RD and BD BHUs. These BHUs occur on moist receiving sites, where upslope seepage supplies abundant moisture for the entire growing season. Toes of morainal and colluvial slopes, and alluvial fans are common landforms for the RD and BD BHUs. The RD has western redcedar and Englemann spruce in all seral stages, along with other indicators of moist soils, such as devil's club, red-osier dogwood, oak fern, and highbush-cranberry. Mosses are generally only moderately developed. The BD occurs on similar sites and is commonly dominated by paper birch in young seral stages, with Englemann spruce as, or more abundant that western redcedar. Thimbleberry, red-osier dogwood, and oak fern are common in the understory. Devil's club is much less abundant. The moss layer is poorly developed on these moist sites.

The AD and the DO BHUs in the SBSdh correspond to the BD and RD BHUs of the ICHmm, respectively, and they occupy the same toeslope and alluvial fan landscape positions. In the AD, trembling aspen dominates early seral stages. This changes to a canopy dominated by Englemann spruce and some subalpine fir when conifers grow through the hardwood canopy as stands age. Red-osier dogwood, thimbleberry and black twinberry are common in the understory, with bunchberry and scattered mosses. The DO BHU represents similar ecosystems as the AD, except that trembling aspen is rare in seral stages, and devil's club is abundant.

In the ESSFmm, moist receiving sites, on both morainal and colluvial materials, are occupied by the FT BHU. Lodgepole pine dominates early seral stages, and is replaced by subalpine fir and Englemann spruce in Mature and Old Forests. Labrador tea is common in the understory, growing with false azalea, black huckleberry, lingonberry, and usually a dense moss cover. At higher elevations in the ESSFmm, ecosystems on moist receiving sites are transitional to the ESSFmmp, and the FV and FL BHUs include these situations. Ecosystems represented by the FV BHU describe gently sloping morainal areas where moist forests of subalpine fir and Englemann spruce are interspersed between lush forb meadows with sedges, subalpine daisy, Sitka valerian, western pasqueflower, and arrow-leaved groundsel. The FL BHU is characterized by lodgepole pine in the early seral stages, which is replaced by open to closed forests of Englemann spruce and subalpine fir. Willow is present in all seral stages, along with bracted lousewort, subalpine daisy, and scrub birch. Moss cover is characteristically moderate to dense.

3.1.4 Floodplain Forests

The SH and TH BHUs (see Table 8) describe floodplain forest ecosystems that abut river and stream channels where landforms are created and destroyed by the flooding effects of the river. Although they represent only a small area of the Park, these unique ecosystems are highly productive and support important wildlife habitat. Soil water levels in these units fluctuate with flooding effects of the river that they border. In the Park, floodplain BHUs occur primarily along the Fraser River in the main travel corridor, and are often associated with extensive wetland areas. The SH represents floodplain communities in the SBSdh and ICHmm subzones. Stands usually are dominated by Englemann spruce at relatively low stocking. Due to the low tree stocking, a dense shrub layer is common and includes species such as willows, thimbleberry, Sitka alder, black twinberry and red-osier dogwood. Common herbs are palmate coltsfoot, oak fern and bunchberry and common horsetail. Mosses are have a low to moderate cover. The TH BHU occurs on floodplains in the ESSF. The TH has low stocking of Englemann spruce in Mature and Old Forest seres, and a dense shrub layer composed of most of the same species as at lower elevation. In the TH, bluejoint, blue wildrye and cow parsnip are common herbs that do not occur in the SH BHU. In the SH and the TH, the moss layer is poorly developed on floodplain sites because of frequent flooding and heavy deciduous litterfall.

3.2 Non-forested Ecosystems

3.2.1 Wetlands

Wetlands cover 2217 ha of the Park, and are found in poorly drained areas along the Fraser River, and in smaller pockets in side drainages. Only one BHU is included in the wetland group according to the biophysical mapping available for the Park. The WS (see Table 8) occurs in all subzones and describes ecosystems where drainage is impeded and a grass-sedge-shrub community develops. Due to the poor drainage, plant decomposition is severely reduced and organic soils have developed. The WS BHU describes areas where sedge fens are interspersed with areas of slightly better drainage occupied by low shrub communities dominated by willows and scrub birch. Common herbs are marsh cinquefoil, common horsetail, water horsetail, and alpine speedwell. Rein-orchids are common in the WS BHU in the ESSFmm subzone.

3.2.2 Avalanche Chutes

Four BHUs occupy avalanche chutes in the Park; the AC, AW, FI, and HT BHUs (see Table 8) for a total of 10 443 ha. The AC (north and east aspects) and AW (south and west aspects) BHUs describe snow avalanche communities on cool and warm aspects, respectively. In the AC and AW the growth of trees is restricted by the persistent mechanical effects of repeated, annual snow avalanching. Site shape is concave so that, during the growing season, avalanche chutes conduct constant seepage resulting in hygric to subhydric soil moisture regimes. This results in the establishment of rich shrub-herb communities where common associates are Sitka alder, thimbleberry, western meadowrue, Canada violet and cow parsnip. A meadow community with grasses such as blue wild rye occurs with fireweed cow parsnip, stinging nettle and sedges, and often develops at the toe of the avalanche chute.

The FI BHU describes steep avalanche chutes that occur in all Park subzones on steep tracks with shallow soils where stunted or young regenerating coniferous stand dominated by subalpine fir develop. Some willow and Sitka alder occurs with the predominantly coniferous coverage. A third type of avalanche chute in the Park is the HT BHU, which develops in snow avalanche areas in the ICHmm subzone. Similar to the AC and AW BHUs, the HT has a steep chute area and a moist toe area. The steep chute is characterized by beaked hazelnut, willows, red-osier dogwood, and cow parsnip. The toe of the chute often supports a shrub-forb community dominated by thimbleberry and cow parsnip, with western meadowrue, stinging nettle, sedges, and fireweed.

3.2.3 Alpine and Subalpine Non-forested Ecosystems

As elevation increases, climate becomes colder and more severe, and, under these conditions, tree growth is no longer possible and forests are replaced by a range of alpine plant communities. The distribution of alpine communities, is the result of the variation in soil moisture and soil nutrient conditions brought about by the interaction of physical factors and the adaptive abilities of the plants available to colonize the sites.

Five alpine BHUs are recognized within the Park, and occupy a total area of 29 554 ha. These include the LV, MC, MP, SP and VP (see Table 8). Alpine and subalpine BHUs can be divided into those on shallow to deep, dry or rocky soils, and those on moist sites where seepage occurs or snow lies late into the growing season. The MC BHU occurs on xeric to subxeric sites on ridge tops, and forms sparsely vegetated communities where white mountain avens, moss campion, and alpine pussytoes are the common plants. Dwarf willow, alpine sedges and partridgefoot occur sporadically in this unit.

Moist alpine areas with late snow and constant seepage support lush communities such as the VP and LV BHUs. The LV develops in both the AT and ESSF zones in the Park, and occurs as a forb meadow with Arctic lupine, Sitka valerian, glacier lily, subalpine daisy and scattered alpine sedges. At similar landscape positions at higher elevation the LV BHU occurs, and supports Sitka valerian, western pasqueflower, sedges, and arrow-leaved groundsel. Other common plants are white mountain heather, bracted lousewort, mountain sagewort, and western springbeauty.

Mesic sites in the alpine areas of the Park support the MP BHU at lower elevations, and the SP BHU at higher elevations. The MP is a low shrub forb meadow dominated by white and pink mountain heather, with alpine pussytoes, sedges, a few willows, and scattered partridgefoot. The SP is an alpine tundra community dominated by sedges, alpine pussytoes and terrestrial lichens, with smaller amounts of moss campion, mountain sagewort, and white mountain heather.

3.2.4 Other Non-forested Ecosystems

Two BHUs, the MH and CF (see Table 8), describe other non-forested ecosystems also occurring in the Park. The MH BHU develops on newly-formed fluvial fans with coarse soils and a minimal amount of subsoil seepage effect. Communities are characterized by a shrub-herb cover of yellow mountain avens and northern hedysarum. Other plants may include willows, broad-leaved willowherb, kinnikinnick, and white mountain avens. The CF BHU describes cultivated fields that support a variety of vegetation, depending on land use history.

Several other communities contribute to the vegetation of the Park and have not been included in the vegetation summary given in Table 8. Emergent wetlands dominated by small flowered bulrush and cattail occupy shallow lakeshore areas, and aquatic macrophyte species such as yellow water lily, water milfoil, and several species of pondweed, are often rooted in the substrate within the water column. As water depth increases emergent vegetation disappears and aquatic macrophytes occupy the lake bottom until substrate or water depth and turbidity become limiting. Aquatic vegetation communities make important contributions to organic matter and energy capture for food chains within lakes in the Park. Similar ecosystems occur adjacent to the slowest moving areas of rivers in the Park, and in conjunction with semi-aquatic wetlands. The lakes and rivers in the Park also support productive phytoplankton populations that contribute significantly to energy capture and nutrient cycling in freshwater ecosystems. Although not considered in detail in this report, it should be emphasized that these plant communities are important to the functioning and biodiversity of the Park ecosystem.

3.3 Overview of Disturbance and Plant Succession Processes

The primary conservation management objective for the Park is the maintenance of natural ecosystem diversity and ecosystem processes. The review of vegetation discussed in the previous section provides a summary of natural ecosystem diversity. Natural and human-caused disturbances are the primary ecosystem processes that have the potential to affect ecosystem diversity at a landscape level. The nature of vegetation succession that follows disturbance will determine the composition of Park vegetation in the long term. The purpose of this section is to review the most important disturbance effects as they relate to important management considerations. Special attention is given to forest fire and insect disturbance, as these two factors have the potential to have the greatest effect on vegetation inside and outside of the Park.

Following disturbance by fire or other agents, forest ecosystems develop through a series of relatively predictable successional, or seral stages. Plant species characteristically are adapted for competing in early or late seral stages. For example, species adapted to the early stages of succession are generally intolerant of shade, prefer exposed mineral soil for germination, and exhibit relatively rapid juvenile growth. In the Park, lodgepole pine is a common early successional tree, especially following fire on mesic and drier sites. Douglas-fir, and trembling aspen are also early successional trees in the Park and occur in successional forests following fire. Black cottonwood is a frequent early successional tree that invades exposed mineral soil following flooding on alluvial floodplains in the Park. Hybrid spruce, western hemlock, and subalpine fir generally occur in the later stages of succession. Their "shade tolerance" allows them to occupy subcanopy positions during early seral stages. They eventually dominate the stands by growing through gaps in the canopy as the early seral species die off. Late successional forests develop into "climax" stands where a state of dynamic equilibrium is achieved allowing species composition to remain stable. Only shade tolerant, climax species are capable of germinating and growing on the deep humus layers and low light conditions that prevail below the canopy. Climax stands persist in this state until destroyed or altered by disturbance, after which the cycle of forest succession begins again.

The most common natural agents of disturbance in the Park have been fire, insect outbreaks, windthrow, snow and debris avalanching, fungal attack, and erosion on alluvial floodplains. More recently, human-induced disturbance associated with land clearing and right-of-way development is also prevalent, especially in the Travel Corridor. The nature of plant succession following these disturbances varies with a host of factors that include:

i) climate, soil moisture, and soil nutrient regime of the site;
ii) age, structure and composition of the stand;
iii)type, timing and intensity of the disturbance, and;
iv)ability of seeds and vegetative propagules to recolonize the site.

Disturbance events, and the forest successions that have resulted, have created a diversity of stand structures and species compositions across the forest landscapes of the Park. For example, extensive young forest stands of lodgepole pine resulting from stand-replacing fire associated with the building of the railroad along the Fraser River are common in the SBSdh. By comparison, almost all stands in the ESSFmm are Old Forest stands and reflect very low levels of stand-replacing disturbance in that subzone. Also, in the Travel Corridor, early seral stages are maintained along road and railroad rights-of-way by vegetation management activities.

Evidence of debris avalanching is visible on the steeper slopes of all of the mountains in the Park, and is most common in the ESSFmm subzone. Debris avalanching destroys forests and initiates primary forest succession, where early successional species often dominate. Whereas, debris avalanches are usually sporadic, long term events that completely remove or bury forest and soil, snow avalanches are annual events that shear vegetation well above the soil surface. In snow avalanche areas, forests often cannot develop because of the shearing and other mechanical effects of snow. Consequently, low shrub-herb communities persist as disclimax successional stages.

Other agents of disturbance such as blowdown, root rot, and erosion are of limited areal extent. Blowdown is seldom extensive, and results in canopy gaps that are filled from advanced regeneration below. Fungal attack by different root rotting fungi is common, but usually affects forests on a very local scale. Alluvial floodplains are areas of constant, small-scale disturbance. Alluvial surfaces are constructed and destroyed by the fluvial activity of the rivers that they border. This results in a mosaic of forested and non-forested plant communities that reflect variations in the frequency of duration of flooding in different areas of the floodplain.

The processes of succession are not restricted to forested ecosystems in the Park. Wetland communities are also slowly changing as water tables fluctuate over the long term, as portions of the wetland are elevated by the accumulation of organic material, and as shallow lake basins accumulate organic material. The interlocking patterns of shrub-carr and sedge-fen evident in wetlands throughout the Park reflect these slow successional processes.

Of all the disturbance effects discussed in this section affecting vegetation composition and development in the Park, the potential impacts of fire and insect outbreaks are clearly the most important for management. Root rots and blowdowns can impact recreational facilities and visitor safety. A major focus of this study is an analysis of forest stability given historical fire suppression efforts, insect mitigation activities, and natural factors.

3.4 Forest Fire

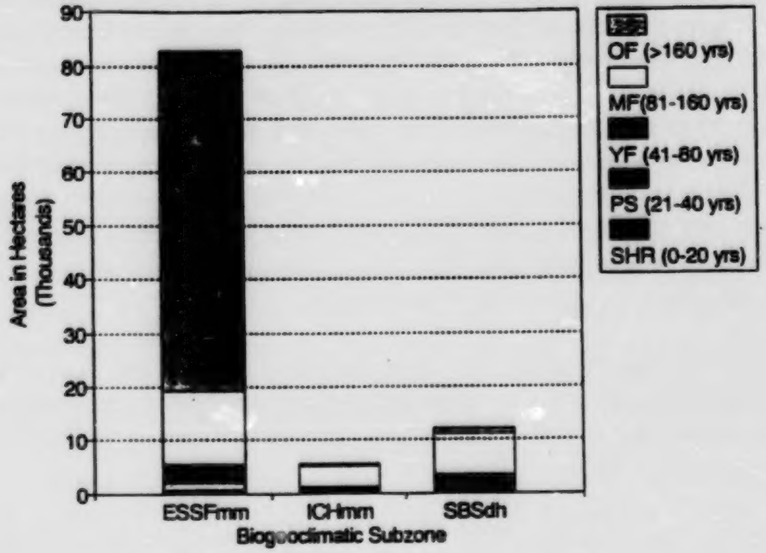
3.4.1 Forest Succession and Fire Suppression

The relative percentage (Table 9) and absolute coverage (Figure 3) of seral stages of forested ecosystems within the three main subzones in the Park show that the majority of forested area is included in the ESSFmm subzone. Within this subzone, a majority of the stands are in the Old Forest seral stage. This distribution suggests that, in the Park, there has been very little recent large-scale, stand replacing disturbance within the ESSF subzone.

Table 9. Forested seral stages expressed as a percentage of the total area of each of the three subzones in Mount Robson Provincial Park

Subzone	Shrub Herb	Pole Sapling	Young Forest	Mature Forest	Old Forest	Total Area (ha)
ESSFmm	0.9	1.4	4.6	16.5	76.6	83 050
ICHmm	0.5	1.1	19.2	69.2	10.1	5823
SBSdh	0.0	0.4	29.1	61.1	9.3	12 430

Figure 3. **Coverage of seral stages within biogeoclimatic subzones in the Mount Robson Provincial Park. (OF=Old Forest; MF=Mature Forest; YF=Young Forest; PS=Pole Sapling; SHR=Shrub Herb Regeneration)**



In both of the lower elevation subzones, the Mature Forest (MF) seral stage has the highest areal coverage (Table 9; Figure 3). In the SBSdh and ICHmm subzones (see Table 9) these Mature Forest stands are made up almost entirely of the AD, DSd, DSs, LS, and PV BHUs (see Table 8), and all were initiated by stand-replacing fire at least 80 years ago. This analysis suggests that few stand-replacing fires have occurred in the last 80 years.

The distribution of seral stages and age classes shown in Figure 3 has been observed in other parks in the Rocky Mountains. The age class distributions for Banff (White 1985), Jasper (Tande 1979), Waterton Lakes (MacKenzie 1973) and Kootenay (Masters 1989) national parks have all shown a reduction in the percent area occupied by the most recent age classes, indicating a lack of stand-replacing fire in recent decades in the whole area. The consistent age class pattern among parks may be the result of successful suppression activities, or may be due to normal climate fluctuations and fire incidence (Kootenay National Park Fire Management Plan). The consistency of the pattern in the four mountain parks and in other regions of Canada, where climates have fluctuated considerably, suggest that fire suppression is the likely cause of the reduction in disturbance. This conclusion is supported by the fact that the six driest years on record occurred in the 1980s (Kootenay National Park Fire Management Plan), yet there are not a large number of stands dating from that period in that area. This is not consistent with a pattern of reduced fire occurrence, unless there has been a reduction in ignition. White (1985) has indicated that the most probable explanation is that the policy of fire exclusion and the resultant fire prevention and initial attack programs have reduced the disturbance regime.

3.4.2 Recent Fire History

Prior to 1950 no records of fires were kept for the Park. Fire history prior to this time is based on observations made in the field and from local historical records. A field reconnaissance of the Park revealed that a large portion of the Travel Corridor and lower elevation forests were consumed in a fire/fires which occurred during the period between 1910 and 1920, predominantly 1913-1915 (Appendix 5). These dates were established by age data that was collected from trees throughout the Park and from forest cover age class data. The majority of sites visited were close to 80 years in age plus or minus 5 years within the Travel Corridor and lower elevations of side drainages. On a large proportion of these sites the age class was overestimated. This overestimation was consistently found to be the result of larger trees growing on higher productivity sites which were photo interpreted to be older in forest cover age estimates. This overestimation in some cases was off by as much as two age classes or potentially 40 to 50 years.

Major fires in low elevations of the Park along the Travel Corridor are likely linked to the development of the railway and were either purposely or accidentally started as a result of railway construction. This is further supported by historical observations published in The Robson Valley Story by Marilyn J. Wheeler (1979).

> *There have been some large forest fires in the valley over the years. Stories of the railway construction days claim that the surveyors were very fond of setting fire to the bush and burning it off, so that they could see where they were going. True or not, most of the valley bottom was burned out just before, and around the time of, the railway's coming through.*

The Ministry of Forests fire reporting system was used to compile a database of fires back to 1950. Numbers of fires have ranged from 0-11 per year. The average number of fires per year by decade are as follows: 1950-1959 - 2.7; 1960-1969 - 1.3; 1970-1979 - 1.5; 1980-1989 - 1.4.

The most significant fire year in recent history was 1958 when a total of 11 fires were reported for the Park. The number of fires is significant and demonstrates the need for fire management.

Table 10 summarizes fires which have occurred between 1950 and 1994 in the Park by size class and cause (lightning-and human-caused). The total number of fires during this period was 74, of which 68% were the result of human causes. The remaining 32% of fire ignitions were lightning caused. Ninety-three percent of all fires that burned between 1950 and 1994 were smaller than 4 ha, while only 3% were greater than 40 ha. The largest fire within the Park since 1950 occurred in July of 1955, and was 202 ha in size.

Table 10. Fire history summary for Mount Robson Provincial Park, 1950-1994

Site Class (ha)	Total No. of Fires	% of Total	Lightning Caused	Human Caused
0.1-4.0	69	93	23	46
4-40	3	4		3
>40	2	3	1	1
Total	74	100	24	50

Table 11 summarizes fire cause by decade and provides some interesting insight into the nature of fire within the Park. Through the 1950s the majority of the fires within the Park were railroad related (48%). Human-caused fires during this decade accounted for over 90% of the ignitions. Lightning fires accounted for only 7% during this time period. From the beginning of the sixties to present human-caused fires have decreased substantially. Through the 1980s human-related ignitions accounted for 42% of the fires compared with 58% for lightning. In the nineties human-caused ignitions have been reduced to 20% while lightning fires have accounted for 80% of all fires. Overall, the total number of fires by decade has remained relatively constant (13-15 fires per 10 years). The only exception to this occurred in the 1950s when 27 fires were reported for the ten year period. The higher average number of fires were attributed to the 1958 season when 11 fires occurred within the Park in a single season. Provincially, 1958 is considered the worst fire season (number of fires) since fire suppression records have been collected.

Table 11. Summary of fire causes in Mount Robson Provincial Park

Decade	Lightning	Recreation	Railroad	Other	Total
1950-1959	2 (7)[1]	4 (15)	13 (48)	8 (30)	27
1960-1969	5 (38)	1 (8)	2 (16)	5 (38)	13
1970-1979	5 (33)	0	8 (53)	2 (14)	15
1980-1989	8 (58)	3 (21)	3 (21)	0	15
1990-1994	4 (80)	1 (20)	0	0	5
Total All Years	24 (33)	9 (12)	26 (35)	15 (20)	74

[1] Numbers in ( ) indicate percentage of total fires for a given decade.

3.4.3 Present Forest Fire Hazard

The forest fire hazard map (Appendix 1) is a graphical representation of landscape-level fire hazard within the Park. In the past, few attempts have been made to develop a comprehensive fire hazard rating scheme of this nature. The purpose of this hazard map is to be the basis of presuppression planning, fire control, and to be a decision-making aid for possible management intervention. The hazard map is a spatial representation of the relative variation of fire hazard in the Park and attempts to provide a framework for assessment of forest fire hazard. It is provided strictly for managers for risk assessment of prescribed fires, natural wildfires, and fire suppression resource requirements. The hazard assessment is not directly related to diversity and wildlife objectives although inferences about fire effects could be determined from this map. The rating scheme makes relative comparisons between stand types. Further refinement and verification of the hazard classification was carried out as part of the 1995 field work.

A large portion of the mapable area was classified as having a low fire hazard. In most cases these low ratings correspond with wetlands adjacent to streams, rivers, lakes, forest stands dominated by deciduous tree species, higher elevation subalpine forests, and non-vegetated alpine areas. High hazard classification is concentrated in the lower elevation valley bottoms and in forests dominated with early successional lodgepole pine and Douglas-fir.

Past studies have shown these high hazard areas correspond well with similar stand types that have been affected by similar disturbance events. Field visits carried out in 1995 verified similarities in stand attributes between high hazard polygons. The distribution of high hazard polygons and fire history disturbance information within the Park is concentrated within the Travel Corridor and strongly correlated with the construction of the railway.

The analysis suggests a need for concern about fires ignited in the central and eastern portions of the Travel Corridor, where the majority of high hazard polygons are concentrated. The significance of these high hazard areas results from their proximity to the Travel Corridor through the Park. Fires within this vicinity pose a significant threat to the public travelling through the Park and would be considered difficult to control given current stand type characteristics and the steep topography of the area. The susceptibility of the area to human-caused fires is considered very high. A public awareness program for Park visitors combined with a good fire prevention, detection and initial attack strategy is required. This hazard rating system has the potential to be used as a tool which can relate future changes in fire hazard, fuel dynamics, presuppresion planning, and fire control to the "naturalness" of the hazard within the Park.

3.4.4 The Estimated Fire Cycle

The reintroduction of fire at the landscape level should be based on prescribed fire and natural wildfires which attempt to mimic natural fire cycles of the past. Both managed wildfires and prescribed fires, which meet specific prescription criteria, should be used in combination to achieve a prescribed fire cycle within a specific area and ecosystem of the Park. The fire cycle is an estimate of the amount of time required to burn over an area equal to the entire forested area being managed. This may not mean all stands burn as some stands may burn more than once during the fire cycle. Fire cycle estimates provide an indication of the timing and probability of fire related disturbance occurring within a certain ecosystem based on historical fire evidence, fire behaviour, and successional pathways.

An approximation of the fire cycle operating within this region can only be determined by a review of the species compositions, age and distributions, and inferred from the biogeoclimatic zones and other studies. A recent fire history compiled for Kootenay National Park (Masters 1989) and Mount Robson Provincial Park has shown that fire has played a major role in forest development. Masters' analysis showed a mean fire return interval for the Park as a whole of 127 years. White (1985) measured fire intervals and time of fire disturbance in ecoregions of Banff National Park and estimated fire cycle values of 40, 85, 125, and 145 years for warm/dry montane, warm/dry lower subalpine, cool/moist lower subalpine, and upper alpine respectively as of 1880. Hawkes (1979) in Kananaskis Provincial Park and Tande (1979) in Jasper National Park derived fire intervals of 18 to 27 years for montane, 74 to 101 years for the lower subalpine and up to 304 years for the upper subalpine.

To aid in the selection and planning of species and ecosystem fire regimes, Heinselman (1978) has described six fire regimes based on an analysis of the literature on fire history of northern ecosystems. These are:

0 = No natural fire (or very little);
1 = Infrequent light surface fires (more than 25-year return intervals);
2 = Frequent light surface fires (1-to 25-year return intervals);
3 = Infrequent, severe surface fires (more than 25-year return intervals);
4 = Short return interval crown fires and severe surface fires in combination (25-to 100-year return intervals);
5 = Long return interval crown fires and severe surface fires in combination (100- to 300-year return intervals);
6 = Very long return interval crown fires and severe surface fires in combination (over 300-year fire return intervals).

A fire cycle of 40-125 years (Heinselman Regime 4) is appropriate for the lodgepole pine, Douglas-fir and spruce forests of SBS zone. This is a conservative estimate based on studies reviewed in the literature and the work of Parminter (1992, 1993) and Masters (1990). The fire evidence described by Parminter (1993) for the ESSF, suggests that a more lengthy fire cycle of between 120 and 150 years (Heinselman Regime 5) is most appropriate for consideration of management objectives within this zone.

3.5 Forest Health

3.5.1 Mountain Pine Beetle

The Mountain Pine Beetle (MPB) is responsible for much of the mortality of mature lodgepole pine in western Canada and the northwest United States (Furniss and Caroline 1980). Other species such as western white pine, whitebark and ponderosa pine are also highly susceptible.

Epidemic infestations of the MPB have been recorded since the turn of the century with the first attempts at control occurring in the 1920s (Richmond 1986). Across the province, the last major epidemic (1979-1986) accounted for almost 200 million dead trees, with a peak of 80 million pine over 460 000 hectares in 1983 (Forestry Canada 1992).

3.5.1.1 Population Dynamics

In most years, populations of the MPB remain at low, endemic levels. They breed in individual or small groups of pines stressed by climatic extremes, diseases, activities of other bark beetles and/or small, low-intensity fires (Amman and Cole 1983; Young 1988). Epidemics occur when sufficient numbers of stressed trees result in the emergence of a large population of beetles in one year. These emerging beetles will subsequently attack and kill large numbers of mature, large-diameter lodgepole pines which produce more beetles the next year. Localized outbreaks in stands generally last from four to eighteen years (Safranyik et al. 1974), ending when host material is exhausted or climatic extremes result in high mortality of brood (Amman and Cole 1983). Epidemics at the landscape or regional level may last thirty years or more since outbreaks in stands are not necessarily synchronous (Schmid and Amman 1992).

3.5.1.2 Potential Impacts

Wildlife, old growth preservation, biodiversity, neighbouring timber values and Park attractions are some of the principle forest use emphases within the Park which could be affected by MPB outbreaks. Old forests of lodgepole pine greater than 140 years do not survive long. The MPB will eventually kill most of these trees. Preservation of these stands is difficult and opposes the natural processes of succession. Large scale, intensive epidemics however, may have significant negative impacts on visitor satisfaction, wildlife abundance and fire hazard.

Infestations by the MPB tend to result in large or clumped areas of dead trees. When populations are low however, single trees may repel beetles or survive as strip attacks. In epidemic conditions, most trees following an outbreak can have a visual impact on Park aesthetics. The visual attraction and visitor satisfaction with the exceptional viewscapes along highway 16 in the Travel Corridor could be seriously reduced by the presence of large numbers of dying and dead trees. Excessive amounts of falling dead trees can pose a hazard and limit access opportunities for wildlife and Park visitors alike. Some recreational and wildlife viewing opportunities along Park trails would likely be hindered following local MPB outbreaks. The excessive contribution of fallen trees and other smaller debris which litter the forest floor may also present a significant fire hazard. In addition to increased fire hazard and reduced park visitor satisfaction, a significant impact from MPB infestations is the threat posed to the lodgepole forests in adjacent areas.

The Robson Valley Forest District, Jasper National Park, and neighbouring lands managed for timber could have their resources placed at considerable risk from an MPB outbreak in the Park. The pine stands which extend through the Robson corridor provide a continuous canopy of susceptible trees for an MPB outbreak to spread through Yellowhead Pass into Jasper National Park and Alberta's pine forests. Resource managers with Jasper National Park, Alberta Forest Service, BC Forest Service, and several timber companies in both provinces have contributed considerable amounts of time and resources over the past twenty years to help avoid the consequences of an MPB outbreak in the Travel Corridor.

3.5.1.3 Historical Infestation Patterns

Mount Robson Provincial Park has not seen a major outbreak of MPB during its recorded history. Several outbreaks however, have occurred in neighbouring forest lands with similar pine types. The Robson Valley Forest District, Revelstoke Forest District and Kootenay National Park have all experienced MPB outbreaks which killed millions of trees over several thousand hectares. Although most of these outbreaks began in lodgepole pine stands at lower elevations, in many cases they quickly spread into stand types similar to those in Mount Robson Provincial Park. The realization that the Robson corridor represented a continuous canopy of susceptible pine trees led to an aggressive program to seek out and destroy the MPB beginning in the early 1980s.

Annual surveys and ground probes conducted by BC Parks staff, B.C. Forest Service staff and the Canadian Forest Service led to the detection of small groups of infested trees near the western entrance to the Park. Between 1985 and 1994, more than 1000 infested pine trees were identified, felled and destroyed within the Park. Over the same period a similar number of infested trees were likewise treated in the Swiftcurrent Creek area immediately west of the Park entrance. The Shale Hill area just east of the western entrance to the Park had the highest frequency of infested trees with an average of 100 trees requiring treatment in each of the past ten years. In 1998-1999 the Swiftcurrent infestation had expanded to 30 000 trees.

The expansive areas of susceptible pine forests in the Park will likely ensure that these local infestations continue for years to come. The probability of an outbreak occurring in the Park is dependent on the continuity of susceptible pine trees and the productivity of the beetles which colonize them. The hazard ratings for the Park's pine stands will show how continuous the susceptible stands are while the yearly surveys and beetle probes will show the aggressiveness of the beetle populations.

3.5.1.4 Mountain Pine Beetle Hazard Map

The Mountain Pine Beetle hazard map (Appendix 6) shows the distribution of hazard classes in lodgepole pine stands within the Park. Only those stands which are made up of 20% or more lodgepole pine are depicted. The bulk of the pine stands in the Travel Corridor fall into lower hazard classes; approximately 23 747 ha of pine stands (86%) were rated as >40% hazard, whereas only 3839 ha (14%) were rated as 40% (Figure 4). Although mortality estimates based on hazard are somewhat imprecise, the hazard values listed on the map legend can be interpreted as the maximum percent mortality of pine during an MPB outbreak. The stands with dark red or purple shading are those which could lose one-half or more of their trees during an outbreak. These are the stands which would likely produce far more beetles than they consume and therefore lead to expanding outbreaks. Stands in the 20 to 40 % hazard classes are those which would not likely lead to an outbreak, but would sustain outbreak populations of beetles emanating from higher hazard stands. This age structure means that many more pine stands will enter high hazard categories in the next 15-20 years (see Appendix 7 for the distribution of age classes in the Park). At the present time, the distribution of high hazard stands is somewhat discontinuous, leading to a reduced probability of large-scale outbreaks occurring (Figure 5). With time, however, the distribution of high hazard stands will likely become more continuous along the Travel Corridor, and an outbreak at that time could devastate many of the pine stands in the Park as well as threaten stands outside the Park. Large areas of high hazard stands or patches of high hazard stands in large areas of moderate hazard stands are the conditions of susceptibility which ensure outbreaks will occur following infestation.

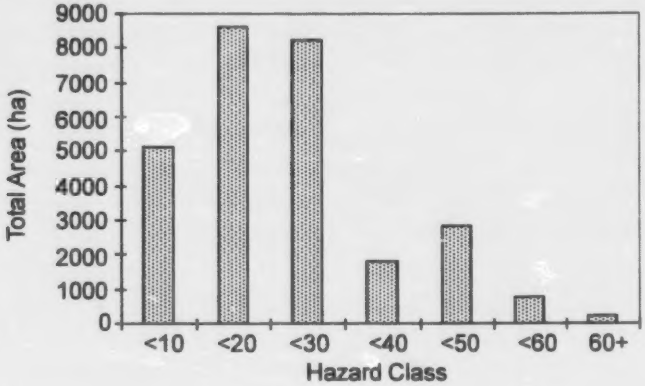


Figure 4. Mountain beetle hazard classes by area

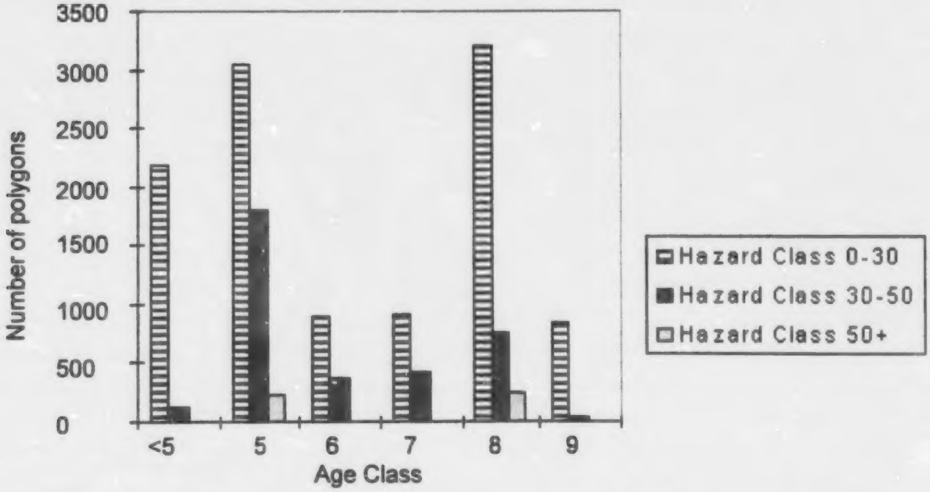


Figure 5. Mountain pine beetle hazard by age class

The hazard map identifies four primary areas of high susceptibility and of immediate concern:

Area 1: The first high hazard area is found near the western entrance along the middle reaches of Swiftcurrent Creek and directly in, and adjacent to, the Robson Meadows and Robson River campsites. High hazard stands at this end of the Park are much more fragmented, suggesting that an outbreak starting here would progress much more slowly across the Park. Campsites, trails and recreation facilities in this area, however, are likely to be directly impacted, emphasizing the importance of continuing to aggressively check beetle populations here.

Area 2: The second area occurs at the western end of Moose Lake and westward along the Fraser River. High hazard stands are much larger any more continuous, suggesting that an outbreak here would be much more difficult to control and would have more of a negative visual impact for tourists.

Area 3: The third area lies along the middle and upper reaches of Moose River. An outbreak progressing here may run out of susceptible types at higher elevations. The upper Moose River and Upright Creek stands, however, are not far from mountain passes, and beetle populations here could possibly be blown over into Jasper National Park pine stands at the head of the Indian and Snaring rivers.

Area 4: The fourth, most concentrated area lies along the Fraser River, half way between Moose and Yellowhead lakes. Examination of the attributes of many of the adjacent, lower hazard stands, indicates that many of these stands are of lower hazard either because the pine component is of age class <4, or pine is not the leading species. These adjacent stands are expected, therefore, to become more susceptible over the next 20 years. If an outbreak were to reach this area, it could very quickly reach unmanageable proportions and the continuity of extensive pine stands to the east suggests that it could move into Jasper National Park.

3.5.2 Spruce Beetle

The spruce beetle (SB), *Dendroctonus rufipennis* Kirby, is endemic to the spruce forests of North America, attacking all native species of spruce. In northern British Columbia, white spruce (*Picea glauca* [Moench] Voss), Engelmann spruce (*Picea engelmanni* Parry), and their hybrids are preferred hosts (Safranyik 1988).

Spruce beetles are a major ecological force in spruce forests, comparable to wildfire (Veblen et al. 1991). Similar to the MPB, the SB is capable of causing extensive tree mortality over large areas. Three major spruce beetle epidemics have occurred in the Prince George Forest Region of British Columbia within the last 30 years, killing over 20 million m^3 of mature spruce (Humphries 1993).

3.5.2.1 Population Dynamics

The spruce beetle's life cycle varies from one to three years, depending on local temperature and microclimate. Beetles in hosts exposed to the sun, in openings and along edges, are more likely to mature in one year (Dyer and Taylor 1971). Thus, forest management practices such as burning or block cutting can affect the percentage of one and two year cycle beetles, and the outbreak potential in a given area.

At endemic levels beetle populations breed in blowdown, slash, stumps, and stressed trees. Shaded windthrow is a major factor triggering spruce beetle outbreaks, as excessive windthrow allows population buildup. Spruce beetle outbreaks in British Columbia have always occurred in the years following widespread windthrow (Safranyik 1985). However, blowdown alone does not always result in population increases. The availability of excessive amounts of breeding material must coincide with favourable climatic conditions, and possibly other factors before beetle numbers will explode.

During epidemics mature, large diameter, standing trees are mass attacked over vast areas. Data from the Prince George and Prince Rupert regions in northern British Columbia indicate a cyclical pattern in population fluctuations (Humphries 1993) over the past 30 years. Regionally, outbreak populations tend to persist for periods of five to ten years, killing tens of thousands of hectares of mature spruce timber. Locally, populations tend to explode and crash over periods of approximately four years (Safranyik 1988).

3.5.2.2 Potential Spruce Beetle Impacts

Like the MPB, large areas of dead timber killed by the SB may increase fire hazard, threatening recreation areas in their vicinity. These areas are unsightly and reduce visual qualities for many tourists. Dead standing spruce may also be hazardous to hikers and other users of the Park.

Spruce beetle outbreaks resulting in massive mortality have a dramatic effect on the surviving forest. In the mixed spruce-balsam stands that dominate the ESSF Zone in the Park, the initial impact is often a change to balsam dominance, and an overall reduction in live basal area (Veblen et al. 1991). Most of the killed spruce remain standing, with a fall rate of 1.5% per year. Since suppressed trees in the understory often escape attack, radiant heat on the forest floor is not intense and seedling establishment is inhibited, preventing establishment of lodgepole pine seral stages. Growth rates of understorey trees may increase dramatically for as much as 100 years (Veblen et al. 1991) resulting in fairly rapid canopy closure. While large outbreaks may create more homogeneity, the forest structure is re-established more quickly than if the site were cut and replanted.

Small infestations of spruce beetle are generally beneficial for forest biodiversity because they create heterogeneity in the forest. Structural heterogeneity such as snags, coarse woody debris, and multi-aged, multilayered stands are attributes considered to be positive for wildlife and overall forest health. The mortality of single, over mature spruce trees may cause a short but significant lichen bloom, improving forage for caribou. Insectivorous bird and mammal species will forage on beetle larvae in attacked trees. Snags resulting from beetle-caused mortality are of primary importance to at least 23 primary and secondary cavity nesting species in British Columbia (Machmer and Machmer 1993). Falling snags create coarse woody debris, also important for wildlife habitat. Canopy openings created by patches of dead trees stimulate the release in growth rates of previously suppressed subcanopy trees (Veblen et al. 1991), creating a mosaic of age classes.

3.5.2.3 Spruce Beetle Hazard Rating Analysis

All spruce stands in the Park were hazard rated using the hazard model in Section 1.3.6. A spruce beetle hazard map was not compiled, as it was not within the original objectives of this project. The results of this analysis indicated that the great majority of spruce in the Park lies within the lower hazard classes; 84 445 ha (97% of all spruce) were rated at <40% hazard, whereas only 2982 ha were rated at 40% or higher (Figure 6).

Unlike the pine stands (Figure 5) most of the spruce component of the Park is older, with age classes 8 and 9 predominating (Figure 7). This suggests that these stands are at higher elevations and escaped the fires which initiated many of the pine-dominated stands in the valley. All of the higher hazard stands lie within these older age classes, although a surprising number of older stands were rated in low hazard classes (Figure 7). Factors such as elevation, site class, and percentage of susceptible spruce caused these stands to be of lower hazard in the model.

While the lack of a GIS-based spruce beetle hazard map analysis and data deficiencies make it difficult to draw concrete conclusions, this preliminary analysis indicates that spruce beetle is likely not a major threat at this time. Lower elevation, pure spruce stands of age class 7 or more should be concentrated upon for monitoring and management.

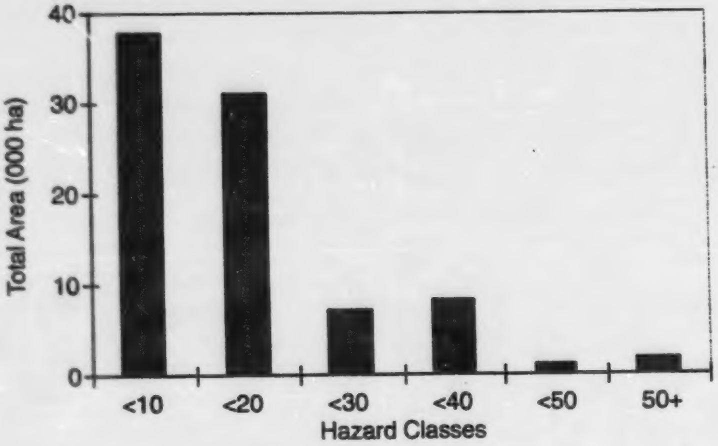


Figure 6. Spruce beetle hazard by area

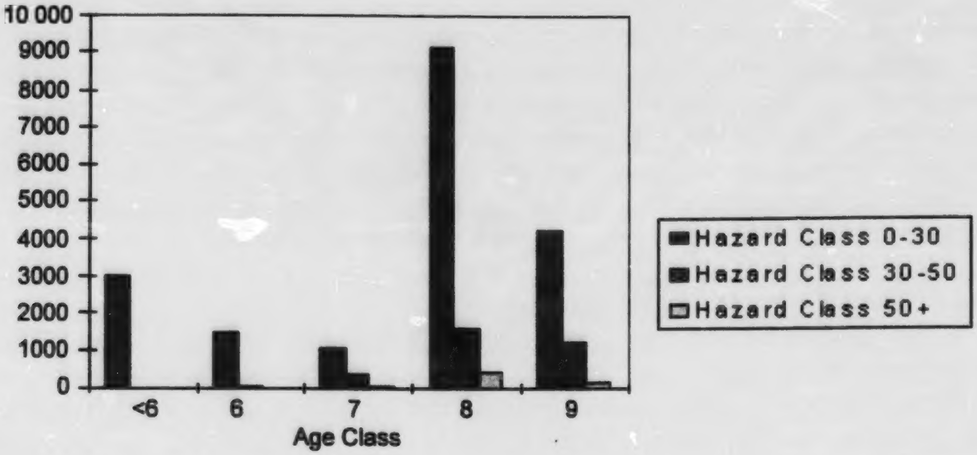


Figure 7. Spruce beetle hazard by age class

3.6 Biodiversity and Wildlife Habitat

3.6.1 Biodiversity Issues and Wildlife Habitat

In the 1992 Master Plan for Mount Robson Provincial Park (BC Parks 1992) the Travel Corridor was designated an Intensive Recreation Zone. The management intent of this designation is to accommodate high numbers of vehicle-based users in as natural a setting as possible. Thus, the area that supports the best wildlife habitat in the Park is also the most heavily developed and visited. The 1992 Master Plan states that steps must be taken to preserve critical wildlife habitat along the Travel Corridor, and to reduce wildlife mortalities along the Travel Corridor, as a result of poaching and collisions with vehicles and trains. Restoration of declining wildlife habitat will be undertaken only when and where it is compatible with other Park conservation management and recreational objectives. According to the Master Plan, wildlife management measures will only be considered in the Natural Environment and Intensive Recreation zones of the Park. Any Travel Corridor wildlife management plan developed must be based on critical feeding habitats (which in the Park are winter ranges), winter range, and migration routes. Recommendations for habitat modification in these areas must augment existing habitats in other zones of the Park.

Large carnivores such as wolf (*Canis lupus*), black (*Ursis americanus*) and grizzly bears (*Ursis horribilis*) are present within the Park. Ungulate species present include moose (*Alces alces*), mountain goats (*Oreamnos americanus*), Rocky Mountain elk (*Cervus elaphus roosevelti*), woodland caribou (*Rangifer tarandus*), mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginianus)*. Mule deer are less common and mainly found in the western areas of the Park. The Sub-Boreal Spruce zone in the Park supports a high density of moose.

Snow depths inhibit deer and elk movement within the Park in winter and often exceed the tolerance of moose in midwinter. Threshold snow levels are 30 cm for deer, 50 cm for elk, 60 cm for caribou, and 70 cm for moose. Some deer, elk and caribou winter in the Park, but they are restricted to low snow habitats. Elk are more common in the drier climates to the east where snow depths are lower. South aspect slopes provide essential winter range during deep snow periods. Deep snow conditions at higher elevations may force ungulates, especially moose and caribou, into the valley bottoms.

The value of the "edge effect" to ungulates is well known (Kelsall and Simpson 1991), and highways create edges. In forested areas particularly, tree seedlings, shrubs, and vegetative ground cover on the highway right-of-way (ROW) may provide irresistible sources of food for browsing and grazing animals. Median strips, particularly if they are wide and support diverse vegetation, are often attractive to large mammals, as Feldhamer et al. (1986) found in their study of highway fences and deer in Pennsylvania.

The transportation routes along the Corridor have a major impact on wildlife year-round. Open slopes along the transportation corridor provide good foraging habitat for ungulates and bears, creating potentially dangerous situations for wildlife and humans. Salt applied to the road surfaces as a de-icer is another attractant to ungulates and is a factor drawing them onto the highway ROW.

In the Park the critical habitats for wildlife are those used during the winter months. These areas are particularly important during years of heavy snowfall, when animals are driven to lower elevations along the Travel Corridor, seek areas of lower snow accumulation. Key wintering areas provide animals with the food, security and thermal cover they need to survive. The ecosystem management plan for the Park should focus on management of moose and caribou winter ranges and spring and summer ranges for deer, elk and caribou. With regard to wildlife habitat, the ecosystem management plan was developed to address the following issues identified in the Park Master Plan:

- to conserve wildlife habitats which are critical feeding areas and migration routes (in the context of this plan winter ranges are considered to be critical winter feeding areas);
- to minimize the number of animals being killed in collisions with vehicles and trains;
- to augment existing wildlife habitats in other areas of the Park;
- to retain trees and snags for wildlife habitat where they pose no danger to people or Park facilities;
- to maintain the diversity of wildlife habitats;
- to provide a plan that is compatible with plans of other parks, in particular Jasper National Park, with regard to elk and caribou migrating between the parks;
- to augment the natural processes of fire, disease, and insect outbreaks to produce high value wildlife habitat in a safe and aesthetically pleasing manner; and,
- to maintain, wherever possible, viewing opportunities for wildlife while keeping them off the highway right-of-way.

In order to minimize wildlife mortalities along the Travel Corridor efforts should be made to reduce wildlife use of the highway and railway right-of-ways. This will affect existing viewing opportunities along the corridor. Vegetation management programs will be used to draw animals away from the Travel Corridor where they are less visible and less susceptible to collisions. Viewing opportunities in some areas will be negatively affected by this plan.

3.6.2 Wildlife in the Travel Corridor

The main species of wildlife affected by the Travel Corridor are moose, deer, elk and bear (black and grizzly). Caribou and goats are not found near the Travel Corridor in large numbers. Kill records indicate that neither have been killed by collisions with vehicles or trains. Wolves are also found in the winter, but no mortality records are known.

Woodland caribou are a blue-listed (vulnerable) species in British Columbia. Therefore, the habitat requirements of woodland caribou are considered to have a higher priority than those for deer, moose and elk. A brief description of the status of woodland caribou populations and their habitat requirements is given below.

Woodland caribou have very specific habitat requirements and do not respond well to changes in the environment due to their relatively low productivity and dependence on relatively stable, old-aged, lichen-producing forest ecosystems. Lichens, the primary winter food of woodland caribou, are found in old growth ESSF forests in the Park. Summer foods favoured by woodland caribou are most abundant in wet, subalpine meadow environments with high forb species diversity. Bogs and fen complexes (muskegs) are also important woodland caribou habitat.

Woodland caribou studied by Brown and Ross (1994) were found to migrate into the southeast corner of the Park between the Fraser River and the boundary with Jasper National Park. These animals were located in the Park year round, but most of the locations were during winter months (1 Nov-30 April) at elevations <2000 m. In 1998 an evaluation of woodland caribou winter range was conducted by Keystone Wildlife Research to further define any critical winter habitat (Appendix 8). This information has now been incorporated into the Ecosystem Management zones.

In winter months, deep snow (> 62 cm) forces most caribou into valley bottom habitats where they were most likely to encounter wolves. In winter, woodland caribou occupy areas with snow depths < 50-60 cm. Sixty-two centimetres of snow was found to be the threshold depth for caribou digging feeding craters for terrestrial lichens in areas of soft snow (Brown and Ross 1994). Woodland caribou wintering in the Park are most likely forced into valley bottom habitat as well by deep snow. In spring the elevation at which woodland caribou were found was related to snow depths; animals moved up valleys until snow depths reached 50-60 cm (Brown and Ross 1994).

Caribou studied in Jasper National Park ate a winter diet comprised of 60-83% terrestrial lichens (Brown and Ross 1994); arboreal lichens were not regularly utilized food items but were thought to become important during winters when snow cover was extremely deep, or snow became crusted and access to terrestrial lichens was limited. Caribou were found to switch to arboreal lichens when they could no longer crater for terrestrial lichens (W. Bradford personal communication).

Predation is generally recognized as the main factor limiting woodland caribou populations (Bergerud 1983; Edmonds 1988; Seip 1992) and predation by wolves has been implicated as a major cause of the decline of woodland caribou in western Canada (Bergerud 1974; Bergerud and Elliot 1986; Seip 1992). Wolf predation was found to be the major cause of adult caribou mortality in Jasper National Park and is most likely the major cause of caribou mortality in Mount Robson Provincial Park.

Habitat changes within a caribou range that occur after forest fires often result in an increase of moose and possibly deer and elk populations, and a corresponding increase in wolf populations (Bergerud 1974). Greater numbers of wolves within a caribou range increase the likelihood of caribou/wolf encounters and caribou population declines may occur (Seip 1992).

For the Park in general, there are gaps in information on caribou as well as lichen growth cycles and growth requirements.

3.6.2.1 Wildlife Habitat

A comparison of the capability and habitat maps indicates that the Travel Corridor contains limited Class 1 moose winter range, extensive Class 2 and 3 moose winter range, and some Class 3 deer and elk winter range. Class 3 deer and elk winter range also lies outside the western boundary of the Park. Deer and elk winter range is restricted to two small areas (approximately 8.5 km^2 and 4.5 km^2 respectively) north of the highway which may account for the limited number of deer and elk wintering in the Park. The Travel Corridor passes through deer and elk winter ranges between kilometres 1-9 and 68-76. Animals congregated on winter ranges near the Travel Corridor are most vulnerable to vehicle collisions, particularly in deep snow winters. During the spring and summer months animals feeding on succulent vegetation along the Travel Corridor and railway right-of-ways will also be highly vulnerable to vehicle collisions.

The only confirmed caribou winter range in the Park lies east of the Travel Corridor from the Fraser River to the Jasper National Park boundary (km 65-76). A second unconfirmed caribou winter range is located at the Moose River-Resplendent Creek junction. Caribou summer range is located along the ridge crest that runs along the eastern boundary of the Park.

Moose winter range is located on either side of the Travel Corridor. The only Class 1 moose winter range lies along the Travel Corridor between kilometres 8-17. Class 2 winter ranges lie along the Travel Corridor from kilometres 17-29, 30-40, 45-47, 49-63, 68-70 and 72-73. Class 3 winter range lies outside the class 1 and 2 ranges for the entire Travel Corridor route except from kilometres 3-5, 27-33 (on the south side only), 40-45, 47-48 and 64-69 where it lies along the Travel Corridor. The Class 2 winter range from kilometres 64-69 is a very narrow band along the Fraser River.

There are several other seasonal ranges that are located near the Travel Corridor, and movement of animals to and from these ranges must be considered in any management plan for the area.

3.6.2.2 Habitat Requirements of Ungulates

Key moose winter habitat consists of wetlands interspersed with mixed deciduous-coniferous forests, revegetated burns and wet areas. Moose have a lower fidelity to seasonal ranges than deer. They will sometimes use winter range in summer and vice versa and will travel up to 50 km between summer and winter ranges (Simpson and Gyug 1991). Moose winter home ranges average approximately 20 km^2. Key shrub species for moose are saskatoon, red-osier dogwood, aspen, cottonwood, high-bush cranberry, maple, willow, alder and birch.

Key deer winter habitat consists of openings mixed with forested areas which provide snow interception, thermal and security cover on dry sites. Snow interception cover is particularly important for deer as they have the lowest tolerance for deep snow. Techniques applied to make habitats more attractive in winter will also produce high value spring and summer deer and elk habitat. Key shrub species for deer are saskatoon, red-osier dogwood, aspen, cottonwood, high-bush cranberry, maple, and, black huckleberry. Mule deer winter home ranges average approximately 15 km^2 in other parts of British Columbia (Simpson and Gyug 1991).

Elk winter habitat requirements are similar to deer, but elk are less dependent on forest cover to intercept snow than deer. Elk winter home ranges also average approximately 20 km^2. Key shrub species for elk are saskatoon, red-osier dogwood, aspen, cottonwood, high-bush cranberry, maple and black huckleberry. Deer and elk use habitats in the Park primarily in the summer, heavy snowloads prevent substantial winter use.

Key caribou winter habitat consist of relatively stable, old-aged, lichen-producing ESSF forest ecosystems, e.g., trees >300 years of age, on north slopes with approximately 40% canopy closure (Alberta Woodland Caribou Conservation Strategy 1995). Caribou show high fidelity to winter ranges. Summer foods favoured by caribou are most abundant in wet, subalpine meadow environments with high forb species diversity. Bogs and fen complexes (muskegs) are also important caribou habitat. Key winter foods for caribou are terrestrial and arboreal lichens.

On deer, moose, and elk ranges forage-producing openings may be created and encouraged to produce the shrub species listed above for winter food. Areas that provide cover require a component with food producing shrubs. On caribou winter ranges trees capable of producing lichens will be encouraged.

Habitat management alone will not solve the present problem of high wildlife mortalities as a result of collisions with vehicles and trains. In applying habitat management the objective is to make areas far from the Travel Corridor more attractive than areas closer to the Travel Corridor. Moose, deer and elk will all move to the most favourable habitat (which is snow depth dependent) in their ranges, which should aid in drawing them off the Travel Corridor. The key to a successful habitat management plan is to create the right mixture of attractive foraging areas, cover-providing areas and unattractive areas in the landscape. The most effective way to accomplish this habitat management is through the manipulation of the age class and stocking density of the existing forest. Between 5 and 30 years will be required before the full effects are realized.

3.6.2.3 Seasonality of Wildlife Utilization

Key habitat units in each range were identified by overlaying the Ministry of Environment Lands and Parks winter range capability ratings on the habitat map polygons. Key habitat units are those that make up the largest proportion of the ranges (Table 12). Lea and Maxwell (1993) rate all the habitat units, with the exception of the rock outcrops, in Table 1 as having abundant potential for winter forage for wild ungulates and moderate summer forage for bears.

Moose

Moose winter ranges in the ICHmm zone are Class 1, 2 and 3. The SH and WS habitat units are the key components of the Class 1 winter range. The BD habitat unit is the key component of Class 2 ranges. The key habitat components of Class 3 ranges are RA, RD, and DDd. Age classes (AC) of these ranges are primarily AC3 and AC4 with a little AC5 in the Class 1 range.

Moose winter ranges in the SBSdh1/dh2 subzones are only Class 2 and 3. Key habitat units in the Class 2 range are composed of AD, DSd and PV complexes. The ages in the Class 2 range are primarily AC3, AC4, and AC5. Key habitat units in the Class 3 range are DSd, DSs, AD and ROW. The ages in the Class 3 range are AC3 and AC4.

Caribou

Caribou winter range is found in the ESSFmm2 zone and contains the following habitats: FT, BL, MH, PA, and TH age class 4 and 5. Caribou summer range occurs on the top of the ridge and Parkland forest along the eastern park boundary and is composed of alpine tundra vegetation age class 5.

Table 12. Key habitat units found in moose, caribou, deer and elk winter ranges in Mount Robson Provincial Park

Habitat Unit	Topographic Position	BGC Zone	Range Type	Forage Species
BD Paper birch-red-osier dogwood	n/a	ICHmm	moose winter	willow, trembling aspen, paper birch, red-osier dogwood
RD Western redcedar-Devil's club	fans	ICHmm	moose winter	western redcedar
RA Western redcedar-false azalea	moderate slopes	ICHmm	moose winter	willow, paper birch, trembling aspen, western redcedar
SH Spruce-common horsetail floodplain	floodplain	ICHmm	moose winter	willow
WS Willow sedge wetland	depressions	ICHmm	moose winter	willow
DDd Douglas-fir-Douglas maple	southerly aspects, deep soils	ICHmm	deer/elk winter	trembling aspen, Douglas maple, saskatoon
AD Trembling aspen-red-osier dogwood	moist lower slopes	SBSdh1/dh2	moose winter	willow, red-osier dogwood, trembling aspen
SH Spruce-common horsetail floodplains	floodplains	SBSdh1/dh2	moose winter	willow
WS Willow sedge wetland	depressions	SBSdh1/dh2	moose winter	willow, sedges
DSs Douglas-fir-saskatoon	southerly aspects, shallow soils	SBSdh1/dh2	moose winter, elk winter, deer winter	trembling aspen, Douglas maple, saskatoon
DSd Douglas-fir-saskatoon	southerly aspects, deep soils	SBSdh1/dh2	moose winter, elk winter, deer winter	trembling aspen, Douglas maple, saskatoon
BL Black spruce-terrestrial lichen	droughty sites	ESSFmm2	caribou winter	terrestrial and arboreal lichens
FT Subalpine fir-Labrador tea	moist lower slopes	ESSFmm2	caribou winter	arboreal lichens

Deer and Elk

Deer and elk winter ranges in the SBSdh1/dh2 subzones are composed of DSs or DSd, ROw and AD complexes. The ages of these ranges are AC3 and AC4.

3.6.2.4 Summary of Historical Roadkill Data

Two data sets were utilized to assess the historical roadkill along the Travel Corridor in the Park (Travel Corridor; Segment 1590). The first was obtained from the Ministry of Transportation and Highways, Environment Branch (A. Murphy, K. Gross personal communication) and dates from 1988 to 1994. It includes the year, month, species killed (although white-tailed and mule deer were not distinguished), and location of kill by kilometre. This information was collected from highway maintenance contractors who picked up dead animals on the highway right-of-way. This data was not recorded with particular accuracy until the creation for the Wildlife Accident Reporting System (WARS) in 1988, so data before 1988 was not included in the analysis. All kill locations were positioned using the Ministry of Transportation and Highways Landmark Kilometre Inventory for Travel Corridor, Segment 1590 and should therefore be considered accurate. It should be noted that this data documents only those animals that die on or within sight of the highway right-of-way; those animals that are injured and move into dense cover are not accounted for. It is possible for seriously injured animals to move off the right-of-way to cover (B. Forbes personal communication). Stuart (1983) estimated that only 43% of wildlife vehicle collisions result in a reported roadside mortality. The Ministry of Transportation and Highways estimates that for every reported accident up to five may go unreported. Kilometre 0 was excluded from the analysis because it appeared that all kills with unknown kilometre locations were assigned to Km 0.

The second data set covers 1990-1994 and indicates the year, month, species and cause of death (vehicle, train, other). Again, deer species were often not distinguished. This data was obtained from BC Parks (W. Van Velzen personal communication) and was collected by full time park employees. Both data sets were compared and duplicate records removed. Because some of the data was incomplete (did not include kill location) not all data was used in every analysis.

Traffic load information was obtained from the Ministry of Transportation and Highways. The data included the Average Annual Daily Traffic (AADT) figures by year, calculated from highway traffic counters located within the Park.

Analysis of both data sets indicates that neither mountain goats or caribou were killed in the Travel Corridor. Nevertheless, using Stuart (1983) and Ministry of Transportation and Highways (MoTH) correction factors (Table 13) it can be estimated that up to 3.6 collisions between caribou and vehicles are occurring. Goats are unlikely to utilize the Travel Corridor due to their preference to steep, rocky terrain. There is no evidence that goats have been killed in collisions with vehicles or trains. Collisions with vehicles (both data sets) killed 104 moose, 62 deer, 24 bears and 12 elk. Collisions with trains killed 2 bears, 4 elk

Table 13. Estimated number of wildlife vehicle accidents occurring in Mount Robson Provincial from 1988-1994

Species	No. of recorded deaths	Stuart (1983) correction factor	No. of collisions by Stuart's factor	MoTH[1] correction factor	No. of collisions by MoTH's factor	Estimated no. of collisions occurring annually
Moose	104	2.23	232	5	520	376
Deer	62	2.23	138	5	310	224
Elk	12	2.23	27	5	60	44
Bear	24	2.23	53	5	120	87
Caribou	0	2.23	2.23	5	5	3.6

[1] Ministry of Transportation and Highways

and 6 moose. Four elk were killed by poachers and 1 drowned. Figure 8 shows high kill locations along the Travel Corridor in relation to winter and summer ranges. One moose died along a fence, 1 died of natural causes and 1 was killed by an avalanche. Vehicle collisions account for 90% of recorded deaths in the Park. Collisions with trains account for 5.4% of recorded deaths in the Park. Correcting these numbers to reflect the two estimates of numbers of accidents that may go unreported indicates that up to 520 moose, 310 deer, 60 elk and 120 bear may have been involved in collisions with vehicles from 1988 to 1994. The average of these two figures provides an estimate of the number of collisions that are likely occurring (Table 13).

From 1988-1994 there were an average of 28.8 kills/year (Figure 9). Table 14 illustrates summary statistics on these kills. Examination of this data by season reveals the following general trends; the highest number of roadkills occurred during the winter months, December to February (44) followed by summer, June to August (40), then fall, September to November (32), the fewest roadkills occurred in the spring, March to May (8) (Figure 10). Roadkills in the summer, spring and fall were correlated with traffic loads (Figure 11). However, the greatest percentage of bear, deer and elk mortalities occurred during summer. Winter roadkills were not correlated with traffic volumes. As previously stated, the Travel Corridor bisects moose winter ranges. The high winter roadkill is believed to be due to moose using winter ranges located along the Travel Corridor. In addition, the Travel Corridor is regularly plowed and salted. This provides wildlife with a readily accessible source of salt as well as a relatively snow-free travel route, which may attract animals into this area.

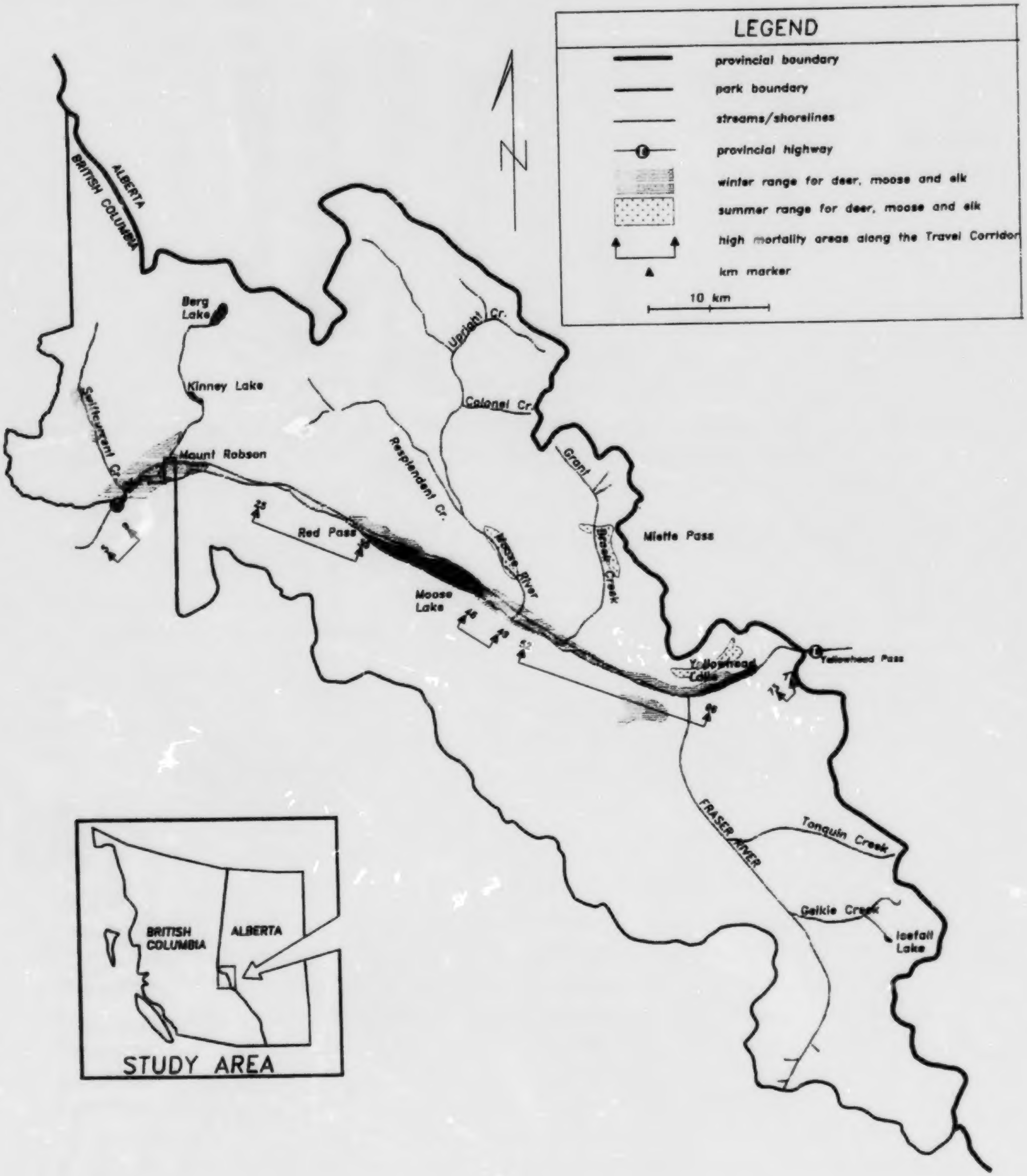

LEGEND
provincial boundary
park boundary
streams/shorelines
provincial highway
winter range for deer, moose and elk
summer range for deer, moose and elk
high mortality areas along the Travel Corridor
km marker
10 km
N
ALBERTA
BRITISH COLUMBIA
Berg Lake
Kinney Lake
Swiftcurrent Cr.
Mount Robson
Red Pass
25
Resplendent Cr.
Upright Cr.
Colonel Cr.
Grant
Moose River
Moose Lake
Miette Pass
Yellowhead Lake
Yellowhead Pass
FRASER RIVER
Tonquin Creek
Geikie Creek
Icefall Lake
BRITISH COLUMBIA
ALBERTA
STUDY AREA

Figure 8. **Locations of high roadkills in relation to ungulate summer and winter ranges**

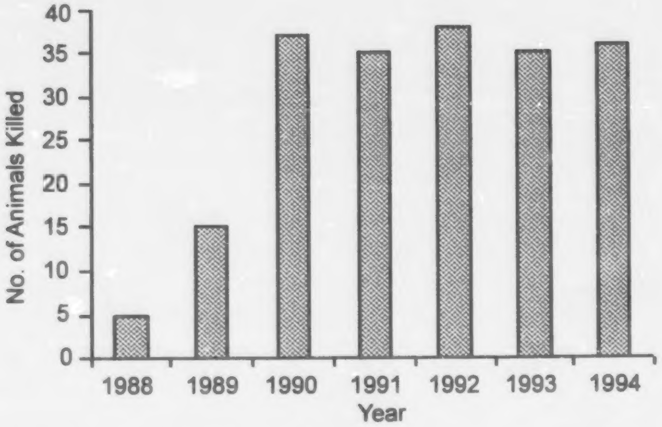


Figure 9. Total number of animals killed on the Travel Corridor annually in Mount Robson Provincial Park, 1988-1994

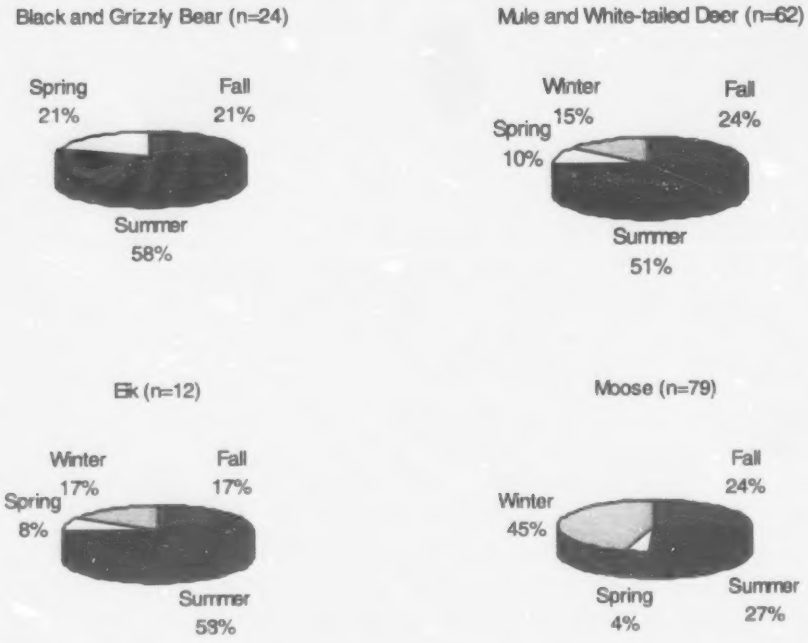


Figure 10. Seasonal distribution of roadkilled bear, deer, elk and moose in Mount Robson Provincial Park, 1988-1994

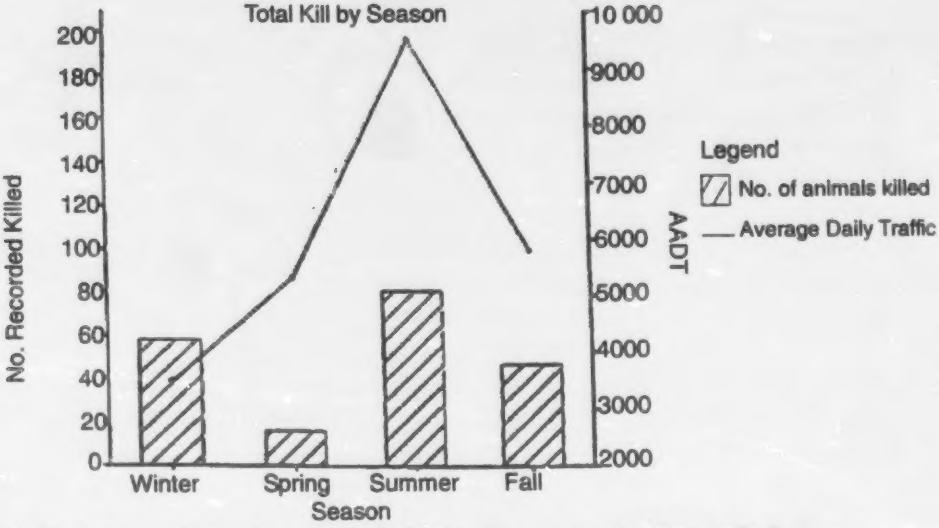


Figure 11. **Traffic load and number of roadkills by the season in Mount Robson Provincial Park, 1988-1994 (AADT=Average Annual Daily Traffic)**

Table 14. **Summary statistics on total roadkills by species in Mount Robson Provincial Park, 1988-1994**

Species	No. of kills	Average annual kill/ year	Average annual kill/ km	Average estimated annual collisions
Moose	104	14.8	.19	53.7
Deer	62	8.8	.11	32.0
Bear	24	3.4	.04	6.3
Elk	12	1.7	.02	12.4

From 1988-1994 there were an average of 28.8 kills/year (Figure 9). Table 14 illustrates summary statistics on these kills. Examination of this data by season reveals the following general trends: the highest number of roadkills occurred during the winter months, December-February (44) followed by summer, June-August (40), then fall, September-November (32); the fewest roadkills occurred in the spring, March-May (8) (Figure 10). Roadkills in the summer, spring and fall were correlated with traffic loads (Figure 11). However the greatest percentage of bear, deer and elk mortalities occurred during summer. Winter roadkills were not correlated with traffic volumes. As previously stated the Travel Corridor bisects moose winter ranges. The high winter roadkill is believed to be due to moose using winter ranges located along the Travel Corridor. In addition, the Travel Corridor is regularly plowed and salted. This provides wildlife with a readily accessible source of salt as well as a relatively snow-free travel route, which may attract animals into this area.

3.6.2.5 Moose Kill by Season and Kilometre

Analysis of moose kill by season shows that 38 moose were killed during the winter, 15 during the fall, 14 during the summer and 2 during the spring from 1988-1994. Fall moose kills were fairly evenly distributed along the Travel Corridor. Moose kills by kilometre are shown in **Figure** 12.

Kilometre 5-9: a high moose winter kill area. This area lies at the western edge of the Class 1 range and in one of the Class 3 ranges. These kills may be due to moose moving into and out of the winter range. PV complexes are the key habitat units here.

Kilometre 25-29: a very high winter and fall kill area. The high kill here is probably a result of a "bottleneck" effect in combination with the thin band of Class 2 winter range. The slopes on either side of the highway are very steep and moose using this range as they travel between the other winter ranges to the east and west will often cross the highway in this area. Key habitats here are AD and PV.

Kilometre 29-35: a very high moose winter and fall kill area. This area contains a thin band of Class 2 winter range along the corridor. It appears that moose may be remaining here year round, possibly due to the extensive second growth forest in other areas of the Park. Key habitats here are DSd, SH and AD.

Kilometre 46-49: the eastern end of Moose Lake, a high non-winter moose kill area. Moose may be moving from the forest on one side of the highway to feed in the marsh and they may also be travelling to and from the summer range located approximately 3 km up the Moose River Valley to the northeast of the highway. The high moose winter kill in this area is believed to be due to moose use of the Class 2 winter ranges in this area. Key habitats in this area are SH and WS.

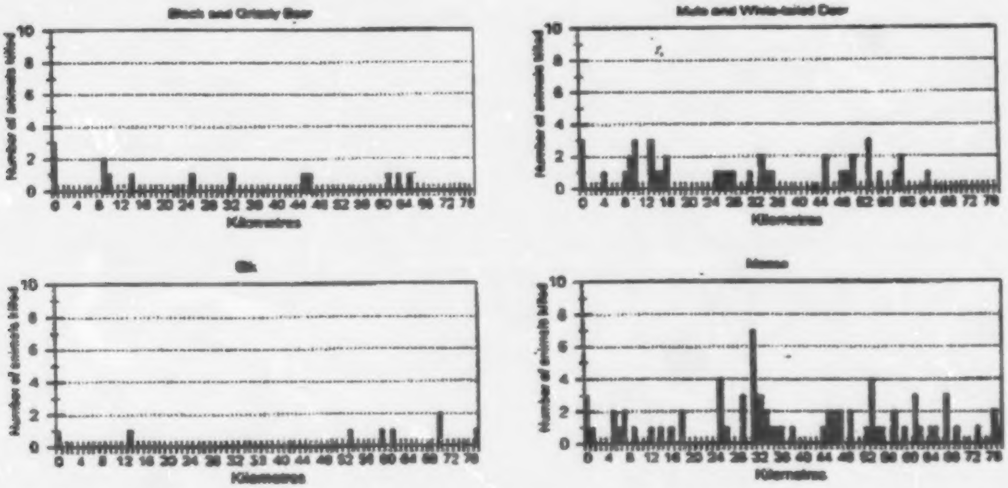


Figure 12. Roadkills in Mount Robson Provincial Park by kilometre, 1988-1994

Kilometre 53: a high moose winter kill area. It lies along Grant Brook at the base of the travel route to the summer moose range located 6.5 km north of the highway. Moose travelling between these two ranges will be in danger as well as those using the Class 2 winter range in this area. The key habitat unit here is AD.

Kilometre 52-62: a high winter moose kill area. The highway bisects a Class 2 moose winter range and is also near the moose summer range located up Grant Brook. Key habitat units here are AD, SH, and WS.

Kilometre 59-66: the high winter moose kill in this area is believed to be due to the movement of moose between the Class 2 and 3 winter ranges located along the highway and the Class 4 winter range (Class 4 ranges have low capability to support moose, especially during winter) at the base of Ghita Creek 1.5 km to the south of the highway. The high non-winter kill may be due to moose remaining in this area year-round or the movement of moose to and from their summer ranges up the fluvial Fraser River and 2 km north of the highway. Key habitats here are SH, AD and PV.

Kilometre 73-77: the high winter moose kill can be attributed to the location of Class 2 and 3 winter ranges with AD, SH and WS habitat units adjacent to Yellowhead Lake. When the highway is plowed in the winter it provides the moose with easy access in and out of this area. Some of the kills here may be due to moose leaving Jasper National Park for winter ranges in the Park.

There are several other ranges located in the Tonquin Valley area of the Park, but animals on these ranges are most likely not using the Travel Corridor. Field observations may confirm this.

3.6.2.6 Deer Kill by Season and Kilometre

Analysis of deer kills by season shows that 5 deer were killed in the winter, 12 in the fall, 17 in the summer and 3 in the spring from 1988-1994. Deer kill by kilometre is illustrated graphically in Figure 12.

Kilometre 8-10: lies east of the Class 3 winter range. The high kill in this area may be due to deer travelling along the highway to this winter range or remaining year round to feed on the highway right-of-way. There are no key winter habitat units here.

Kilometre 13-16: a high kill area all year. This area lies east of the Class 3 winter range. The high kill in this area may be due to deer travelling along the highway to this winter range and remaining year round to feed on the highway right-of-way.

Kilometre 25-35: a high summer kill area. This area does not lie in any identified deer range. It is not known why the deer kill is so high in this area.

Kilometre 53: a high fall, spring and summer kill area. This area lies along the base of Grant Brook and contains the key habitat unit AD. This area may provide more nutritious forage for deer than other areas nearby.

3.6.2.7 Elk Kill by Season and Kilometre

Analysis of the elk kill by season shows that 5 elk were killed in the summer, one in each of the fall and winter and none in the spring from 1988-1994 (Figure 12). Summer elk kills occurred at Kilometre 59-61 (2 kills) Kilometre 53 (1 kill) and Kilometre 70 (2 kills). The winter elk kill was located at kilometre 77 while the fall elk kill was at kilometre 13.

Due to the low numbers of elk roadkills within the Park, no correlations can be made with habitat. Elk in Jasper National Park are known to move through the corridor to gain access to the Robson Valley and elk are slowly populating areas west of the Park. The Travel Corridor is a key movement route for elk in the area, making them vulnerable to vehicle collisions.

3.6.2.8 Bear Kill by Season and Kilometre

Analysis of bear kills by season shows that 4 bears were killed in the summer, 3 in the spring and 4 in the fall from 1988-1994. Bear kills appear to be randomly distributed (Figure 10). Again, due to the low numbers of roadkills, there is no predictable habitat trend among the kill locations recorded. Bears are wide-ranging and their extensive travels may take them across the highway more frequently than other species. Bears may frequent wetland units along the highway and may also be attracted to roadkilled ungulates.

3.7 Non-native Vegetation in the Travel Corridor

3.7.1 Vegetation Management Issues along Right-of-Ways

A number of transportation and industrial right-of-ways (ROWs) travel through the Park along the Travel Corridor. Highway 16 enters the Park from the east just south of Portal Lake, travels south of Yellowhead Lake and the Fraser River to a crossing just west of Ghita Creek, parallels the north side of the Fraser River, Moose Lake, and the Fraser River again until it passes out of the Park to the west. The Canadian National Railway ROW enters the Park from the east to the north of Portal Lake and parallels the north side of the Yellowhead Lake, the Fraser River and Moose Lake to Redpass Junction, where it crosses to the south side of the Fraser River, doubles to a twinned line, and then passes out of the Park to the west. The Trans Mountain Pipe Line and BC Telephone Fibre Optic ROW runs parallel to Highway 16 through the Travel Corridor, and is somewhat smaller, with a width of about 10 m.

Right-of-ways in the Park have historically been subjected to various kinds of vegetation management activities including chemical, mechanical, and manual brushing. The disturbance created by these activities have made available ecological niches for which native vegetation is often out-competed by invasive non-native weedy plants that can aggressively colonize and dominate disturbed ground. According to the BC Parks

Conservation Program Policies (1997) exotic or non-native plant species will be managed and/or controlled to protect and/or conserve ecosystem health and biodiversity. Colonization by non-native plants in disturbed areas along corridors is clearly in conflict with this objective. A second problem associated with vegetation along ROWs is the attractive forage characteristics of the grass and forb communities that develop following vegetation management (see Section 3.6.1). Ungulates are attracted to the ROWs, where the potential for collisions is a major management issue along the Travel Corridor and CNR ROW.

3.7.2 Non-native Vegetation in other Areas of the Park

Colonization and persistence by non-native vegetation in the Park is not restricted to the ROWs described above. Other disturbed areas occur around Park buildings, in gravel pits, and along well-travelled trails and highly used campsites. Non-native species use the ROWs as access corridors, and then may occupy these areas within the Park. Also, horses can bring seeds of non-native forage species into the Park through their digestive systems and deposit them along trails. Where trail traffic has been high and mineral soil is exposed, available niches may exist where non-native plant seeds can establish and persist. Gardens and other areas landscaped with non-native plants within the Park also represent a risk of escape for some species.

3.7.3 Vegetation Management along Right-of-Ways

The present methods of vegetation management along ROWs in the Park clearly compromise Park objectives for two reasons:

i) they create plant competitive conditions that are amenable to the establishment of aggressive, non-native weedy species that compromise native ecosystem biodiversity; and
ii) they are attractive to wildlife, and this results in unacceptable numbers of highway and railway fatalities for Park ungulates.

Solving these problems will involve coordination with adjacent agencies, and the joint development of an adaptive management approach for dealing with vegetation management issues along right-of-ways in the Park. Management issues and priorities are discussed in Section 5.0, and specific recommendations in Part 2.

4.0 Adjacency Issues

4.1 The Greater Yellowhead Ecosystem

Environmental factors affecting many ecological processes in the Park reach far beyond Park boundaries, and their entirety is considered as the Greater Yellowhead Ecosystem. Ecological factors operating at a global scale and over very long time periods can directly and significantly affect Park ecosystems. Long term climatic change, or changes in earthquake frequency and intensity are examples of this kind of effect. More localized, but still very far reaching ecological processes affected by factors far outside the Park boundaries include effects on migratory birds and anadromous fish. Most of these factors cannot be directly addressed in this management plan, either because they represent natural variability or because they are well beyond the jurisdiction of BC Parks. However, BC Parks should, whenever possible, state the importance of human activities on global warming, or on the conservation of migratory and anadromous species, to the relevant international and national agencies.

There are a number of extra-boundary management issues that can be influenced by management activities in the Park, and by Park neighbours, and these are the major focus of this section. The most important of these are:

i) the spread of wildfire and pest outbreaks across Park boundaries;
ii) the management of far-ranging wildlife populations such as caribou and carnivores; and
iii) the control of the spread of non-native vegetation along ROWs that travel through the Park.

In the context of these issues, the Greater Yellowhead Ecosystem includes the western regions of Jasper National Park and eastern areas of the Robson Valley Forest District along the Rocky Mountain Trench. Communication among neighbouring stakeholders is required to develop coordinated management approaches to deal with these adjacency issues. Ongoing initiatives among neighbouring stakeholders are described below.

4.2 Neighbouring Stakeholders

As shown in Figure 13, neighbouring stakeholders that abut the Park can be divided into two major jurisdictions the Robson Valley Forest District to the west and Jasper National Park to the east. The entire neighbouring area along the northwest to southwest boundaries is Crown Land under the jurisdiction of the British Columbia Ministry of Forests. The one exception is Mount Terry Fox Provincial Park, administered by BC Parks. Two forest license holders operate in some of the adjoining area as noted on the map. These are Slocan Forest Products Ltd. in the Hugh Allan and Yellow Jacket drainages, and Hauer Brothers Ltd., to the northwest in the Swift Current and Spittal drainages. Other drainages that abut the Park to the west are administered by the Robson Valley Forest District under the small business program. Thus all of the land to the west is managed for commercial forestry, and fire or pest outbreaks spreading out of the Park could compromise these objectives and investments.

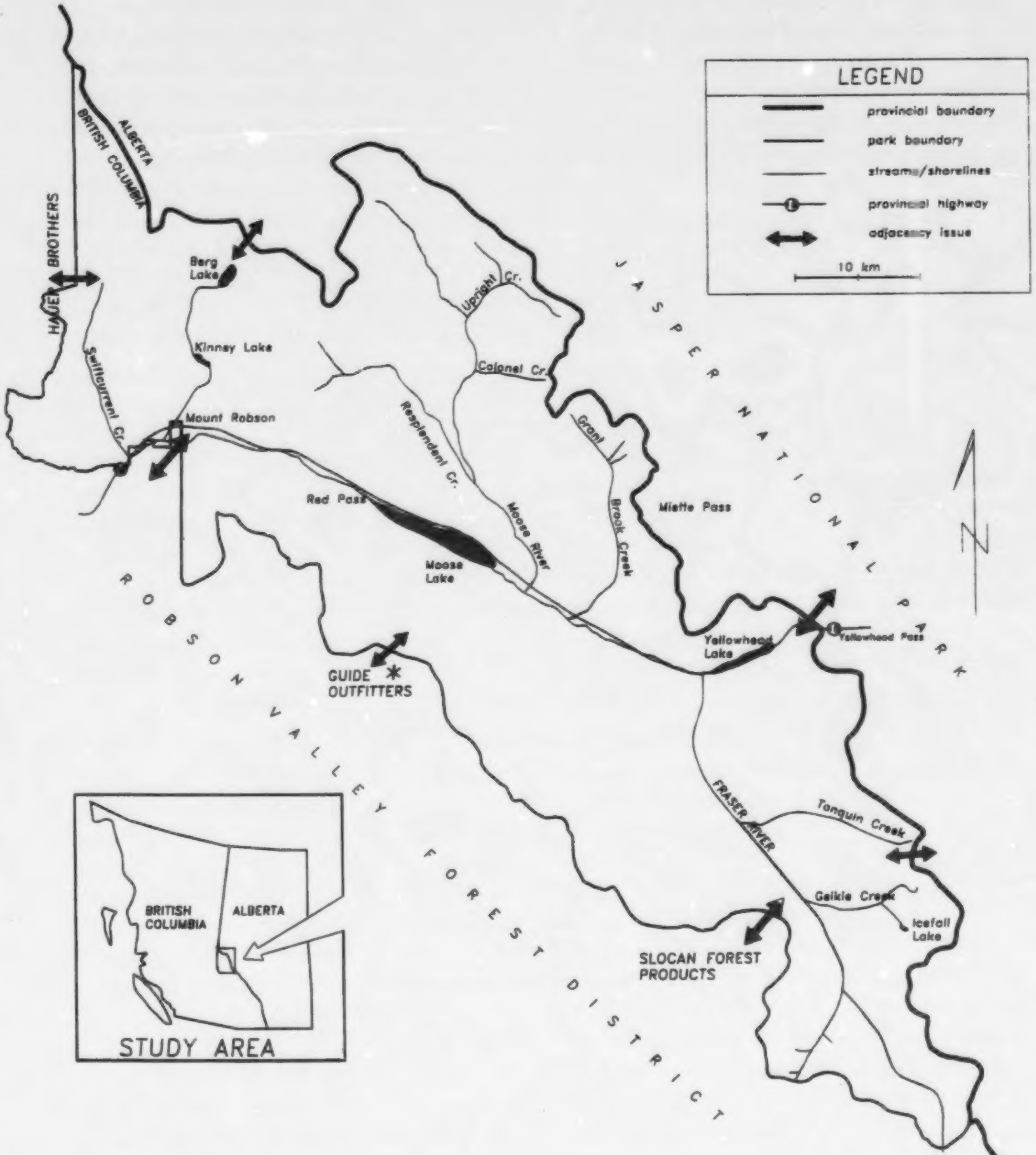

LEGEND
provincial boundary
park boundary
streams/shorelines
provincial highway
adjacency issue
10 km
ALBERTA
BRITISH COLUMBIA
HAUER BROTHERS
Berg Lake
Kinney Lake
Swiftcurrent Cr.
Mount Robson
Upright Cr.
Colonel Cr.
Resplendent Cr.
Grant
Brook Creek
Moose River
Miette Pass
Red Pass
Moose Lake
JASPER NATIONAL PARK
Yellowhead Lake
Yellowhead Pass
GUIDE OUTFITTERS
ROBSON VALLEY FOREST DISTRICT
FRASER RIVER
Tonquin Creek
Geikie Creek
Icefall Lake
SLOCAN FOREST PRODUCTS
BRITISH COLUMBIA
ALBERTA
STUDY AREA

Figure 13. Stakeholders adjacent to Mount Robson Provincial Park

From the northeast to the southeast boundary Jasper National Park abuts the Park (Figure 13). Management objectives and strategies for Jasper National Park are under development, in conjunction with the Four Mountain Parks (personal communication Mike Wesbrook, Jasper National Park). In general, management objectives for Jasper National Park are much more similar to those presented here for Mount Robson Provincial Park, than for commercial forestry interests to the west. However, if the management approaches presented in this plan for Mount Robson Provincial Park are to be successful, they will have to be communicated and coordinated with managers in Jasper National Park to ensure compatibility across this common boundary.

4.3 Management Issues

As stated in Section 4.1 above, the three major adjacency issues for the Park are the potential for wildfire and pest outbreaks to travel across Park boundaries, the management of ungulate and carnivore populations that cross Park boundaries, and the spread of non-native vegetation along ROWs.

Figure 13 shows the stakeholders adjacent to the Park, and arrows in the figure indicate the most likely areas where fire or pests might spread out of or into the Park. These are principally the low elevation valleys at the extreme east and west end of the Travel Corridor. Almost all other boundaries for the Park are located along high mountain divides. A combination of high humidity, ground covered by alpine vegetation, rock, or icefields, or discontinuous forests of subalpine fir, Englemann spruce and scattered lodgepole pine mean that wildfire or pest outbreaks would probably not cross out of the Park in these areas. An exception is the Ptarmigan Pass area (small arrow in southwest boundary) where subalpine forests dominated by subalpine fir and Englemann spruce are continuous across the pass. There is a small possibility of a fire or pest outbreak travelling through this low pass, and special attention should be paid to evaluating the potential for any fires or pest outbreaks in the adjacent Fraser River Valley within the Park. This issue is addressed in detail in Part 2.

Even-aged stands 70-80 years of age are continuous along the complete length of the Travel Corridor within the Park. As these stands age over the next 20 years they will become more susceptible to potential large scale attack by mountain pine beetle. Given the continuity of the stands, such an epidemic could spread out of the Park along the corridor to the east or to the west. In the area directly adjacent to the eastern boundary of the Park, Jasper National Park is dominated by lodgepole stands of a similar age class, so these stands could continue to carry the outbreak. The potential then exists for such an outbreak to spread into commercial forests to the east of Jasper National Park. The serious potential for mountain pine beetle outbreaks starting inside the Park to travel across Park boundaries, or for forests within the Park to carry an outbreak started outside of the Park, seriously constrains a no action management approach with regard to mountain pine beetle outbreaks within the Travel Corridor. This issue is discussed later in this document, and a management approach for dealing with the mountain pine beetle outbreaks is outlined in Part 2.

The Travel Corridor also presents a potential conduit for wildfire to spread out of the Park into adjoining areas. The entire lower elevations of the Travel Corridor are presently dominated by 80-90 year old lodgepole pine and Douglas-fir stands that have regenerated after fires associated with railway development in the early 1900s. Veteran Douglas-firs in these stands provide evidence that wildfire has been common in these forests for hundreds of years before these most recent fires. If mountain pine beetle outbreaks kill significant numbers of trees over the next 20 years, this will add considerable surface and standing fuels, which also increases the hazard of widespread fire. Taken together, the history of repeated fire, the even-aged nature of the stands, the interaction with mountain pine beetle outbreak hazard, and the continuity of the stands along the Travel Corridor represent a considerable long term hazard to Park infrastructure, visitor safety, and to Park neighbours. As a result, active management strategies such as prescribed fire, are recommended in Part 2 to deal with this issue. Ongoing communication with Park neighbours is an important component of developing compatible risk management strategies.

A second important group of issues requiring interaction and communication with Park neighbours is the management of wildlife populations that range across Park boundaries. Of special significance due to their designation as threatened, is the woodland caribou herd whose distribution is centered in Jasper National Park, and who range into the eastern portion of the Park. A second important concern is the management of far ranging carnivore populations, including grizzly bears, elk, wolves, wolverine, and cougar. As for fire and pest management, the proper management of all of these issues will require ongoing communication with Park neighbours.

The third major adjacency issue of concern is the spread of non-native vegetation along ROWs that traverse the Park, and that also traverse Jasper National Park to the east and British Columbia Crown Land to the west (see Section 3.7.2). As discussed above, inventory work is underway in Jasper National Park, and 96 non-native species have been identified to date (Biota Consultants 1993). In that climatic conditions and the nature of disturbance along ROWs are similar in Jasper National Park and Mount Robson Provincial Park, it is reasonable to assume that a similar number and species composition of non-native plants occupy disturbed ground in the Mount Robson Provincial Park, and this was confirmed generally during the field work conducted for this study. Since ROWs serve as corridors to disperse non-native weedy vegetation, cooperation between adjacent jurisdictions needs to be arranged so that coordinated approaches can be developed.

4.4 Ongoing Interagency Management Initiatives

4.4.1 Yellowhead Ecosystems Working Group

At the present time there are a number of interagency initiatives that are designed to deal with adjacency issues in the Greater Yellowhead Ecosystem. One such initiative is the Yellowhead Ecosystem Working Group (YEWG), formed to better coordinate resource management issues among neighbouring jurisdictions along the Yellowhead Highway from Edson to McBride. The nine issues identified for action by the group are:

i) information sharing;
ii) common data collection and management;
iii) caribou conservation;
iv) grizzly bear conservation;
v) fire management;
vi) access;
vii) mountain pine beetle management;
viii) distribution and representation of habitat types; and
ix) the role of disturbance processes.

Members of the YEWG include representatives from Foothills Model Forest, Alberta Wildlife, Jasper National Park, Weldwood of Canada (Hinton Division), BC Parks, B.C. Forest Service, BC Environment, and Slocan Forest Products Ltd. The first two issues for the YEWG are to: 1. develop a common ecosystem mapping approach for the area, so that ecosystem and habitat conservation issues can be coordinated and addressed, and, 2. the Yellowhead Carnivore Working Group, which has begun to coordinate the management of far-ranging carnivore species. As one aspect of the latter objective, the Yellowhead Carnivore Working Group expects to coordinate with work presently being carried out by the World Wildlife Fund, the East Slopes Grizzly Project, and the B.C. Grizzly Bear Conservation Strategy to better pool resources and knowledge for developing integrated grizzly bear management strategies in the region. A group such as the YEWG provides an ideal method for communicating management approaches and developing coordinated regional ecosystem management strategies that do not duplicate effort, and thus make better use of available funds and expertise. For example, Part 2 of this management plan presents a number of land management approaches that can have direct effects on neighbours, as discussed above.

4.4.2 Four Mountain Parks

Mount Robson Provincial Park is contiguous with Jasper National Park and, as a result forms a natural continuum with other national parks in the Mountain District – Banff, Kootenay, and Yoho. Parks Canada staff are in the process of developing an integrated vegetation management plan for all four parks, and the principles for such a plan are outlined in Draft Management Strategy, Parks Canada, Mountain District (Alberta Region Vegetation Management Advisory Board 1995, Preliminary Draft). The general objective for vegetation management in the Four Mountain Parks is the same as that stated for Mount Robson Provincial Park, that is, to allow natural processes to fulfil their roles in sustaining the integrity of ecosystems. Parks Canada realizes that this objective will be constrained by other factors. Using an adaptive management approach, where interventions are treated as experiments in which results are carefully monitored and assessed, general program goals are also similar to the Park:

i) Fire: to maintain or restore natural fire regimes while ensuring adequate public safety and facility protection, and considering the objectives of adjacent land managers;
ii) Forest insect and disease: to allow fluctuations of natural, dynamic populations of forests insects and disease with minimal interference;

iii) Non-native plants: to prevent free introduction of non-native plants and to eliminate or control them, as practical, in support of maintaining natural plant diversity; and

iv) Special features: to protect and maintain special plant features, species, populations and communities, including those that are vulnerable, threatened or endangered, of scientific interest or interpretative value, or are locally, regionally, or nationally significant.

The draft also addresses natural herbivory regimes, disturbed sites, and regional landscape relationships. All of these objectives are compatible with those proposed for Mount Robson Provincial Park. As specific plans are developed by Parks Canada it is important that they be integrated with the implementation of vegetation management actions in the Park. The YEWG provides an ideal process for integrating these regional objectives and the maintenance of the group should be considered a priority.

4.4.3 Robson Valley Round Table–Protected Areas Strategy

A principal objective of the Park is the conservation of the ecosystems and ecosystem processes that fall within its boundaries. In a provincial context, Park ecosystems are part of an inventory of natural areas being summarized and assessed within the provincial Protected Areas Strategy (PAS), and specifically for the Robson Valley Round Table PAS. In 1999, the provincial government approved a 6038 ha expansion of the Swiftcurrent drainage onto Mount Robson Provincial Park. This plan does not address the revised Swiftcurrent boundary.

5.0 Active Management Approaches and Options

Permitting natural disturbances to occur without intervention will be limited, at least in some sections of the Park, by a number of constraints. These constraints have already been identified, and include conservation of rare, endangered, or threatened species or habitats, old growth and biodiversity conservation issues, adjacency issues, and visitor safety. A range of options are considered to attempt to deal with some of these issues, and these are reviewed below.

5.1 Management Approaches for Controlling Non-native Vegetation

Management interventions to deal with non-native species are well-advanced in Jasper National Park (Biota Consultants 1993; Vujnovic and Wein 1994), and the approach to be taken by Parks Canada has been dealt with at a regional level by Achuff et al. (1990). Clearly, an inventory of the severity and nature of the problem is the first step for Mount Robson Provincial Park. Biota Consultants (1993) added to a non-native plant survey already completed, and determined that, out of a total vascular flora of 798 species in Jasper National Park, 96 were non-native. The entire area of Jasper National Park has not been surveyed, so more species may be found in the future. The surveys carried out to date concluded that non-native plants are widespread in Jasper National Park, and that, given the persistent nature and isolated dispersal of many of the species, and the potential for new species to invade at any time, complete eradication will be impossible. As a first step, Biota Consultants (1993) recommended that priority should be given to weedy species listed under the Weed Designation Regulations of Alberta, and especially those listed as 'restricted weeds', i.e., weeds that must be destroyed by the landowner. To this end, Vujnovic and Wein (1994) carried out a literature search to summarize physical characteristics, life history information, and best management approaches for ten of the weed species in Jasper National Park. Based on this information and survey data from the Jasper National Park, Vujnovic and Wein (1994) recommended site specific prescriptions for dealing with these weeds. Biota Consultants (1988) also recommended that priority should be given to those areas where native ecosystems are presently being invaded by non-native vegetation.

Strategies to deal with non-native plants in the Park should draw on the experience and work that has already been carried out in Jasper National Park. The first step in developing management approaches for controlling or limiting non-native vegetation in the Park is to conduct an inventory to determine;

i) what non-native species are present;
ii) the distributions of these species within the Park;
iii) the Agriculture Canada status of the plants surveyed, i.e., those listed as noxious or restricted;
iv) where localized populations can be relatively easily eradicated; and
v) where the most serious invasions into native ecosystems have occurred.

The inventory should include all ROWs, as well as other disturbed ground, motor and backcountry campsites, and along trails. Based on this inventory, a suggested general management approach for dealing with non-native vegetation is to:

i) prioritize existing non-native plant species for direct intervention;
ii) identify areas where small localized populations can be easily eradicated;
iii) develop most appropriate control measures for eradicating species populations (see Achuff et al. 1990); and
iv) develop guidelines for any future construction in the Park that may result in the invasion of non-native plants.

All intervention should be coordinated with Jasper National Park, the Canadian National Railroad, B.C. Ministry of Transportation and Highways, BC Telephone, and Trans Mountain Pipeline, and where appropriate, joint funding for inventory and eradication efforts should be arranged between BC Parks and the appropriate agency. Once clearly stated, permit holders with ROWs in the Park should be responsible for meeting Park objectives along their ROWs.

5.2 Wildlife Management Along Travel Corridors

5.2.1 Wildlife Access Control

Analysis of both data sets shows that vehicle-induced wildlife mortality in the Travel Corridor is a serious problem. The number of moose that are being killed along the Travel Corridor is especially significant. Winter kills are not correlated with traffic load. This is probably due to the fact that the Travel Corridor bisects traditional winter ranges, resulting in a concentration of animals using the Travel Corridor during the winter months, and increasing the likelihood of wildlife/vehicle collisions.

Low kills in 1988 and 1989 can be correlated with low traffic volumes. An analysis of variance ($p<0.05$) showed that there is no significant difference in number of wildlife traffic mortalities for the years 1990 to 1994. The roadkill in the Park is stable at this time. However, if traffic loads increase, then roadkill rates will most likely increase as well.

Moose

Moose kill (both winter and non-winter) is seen to be related to the position of winter and summer ranges along or near the highway. This suggests that the best way to control moose mortalities is through access control which will reduce the frequency of crossings. Habitat management may help reduce the number of kills but, it will not drastically alter moose traditional use patterns in the Travel Corridor area.

Caribou

No caribou have been killed along the highway or railway. Caribou do use habitats near the highway but apparently do not cross the highway. Caribou move into Jasper National Park along the valley bottom or through mountain passes. Vegetation management to maintain the caribou winter range should be sufficient to maintain traditional caribou movement patterns.

Deer

Deer roadkills do not appear to be highly correlated with the location of traditional ranges. The majority of the deer roadkills occur in the non-winter months, indicating that deer are not using the Travel Corridor in the winter to a large degree. The high non-winter kill is in part a function of traffic and may also be due to the fact that deer are attracted to the highway right-of-way by the grassy medians that are kept in good condition through regular maintenance. Vegetation management aimed at creating attractive forage for deer off of the right-of-way, in combination with management aimed at reducing the palatability of right-of-way forage, may aid in reducing collisions with deer.

Elk

Few elk have been killed on the highway in the Park. Those that are, are probably dispersing from the population centre in Jasper National Park. Habitat management in the Park will increase elk use of the area, and may increase the number of roadkills. Vegetation management programs should consider the need to provide attractive habitats away from the Travel Corridor and a means of discouraging elk use along the highway. This will be discussed in further detail in Part 2.

Bears

Few bears are killed in the Park and the locations are not correlated with habitat. The five kills at Kilometre 77 may be due to animals moving between Jasper National Park and Mount Robson Provincial Park. There is little that can be done to control these mortalities. The average loss within the Park has been 1.2 bears per year. This number should not be a significant concern for the Park population.

Most of the roadkills occur in areas where the highway passes through important seasonal ranges. Most accidents with deer, elk and bears occur in summer when those species are moving through the Park and traffic volumes are at their highest. Moose suffer highest losses in winter even though traffic is substantially reduced. This relates to the number of animals confined to areas close to the highway by deep winter snow and to the potential of a cleared and salted highway to attract moose in winter. Some mitigation may be achieved by vegetation manipulation which provides high quality cover and forage for moose in areas removed from the road right-of-ways. Some wildlife exclusion fencing can often be justified based on the benefits to motorists in reducing damage, injury and death resulting from collisions. Moose, because of their height and weight, are particularly dangerous to motorists when they frequent high speed highways.

5.2.1.1 Wildlife Exclusion Fencing

The following information relating to mitigation of wildlife/highway conflicts has been extracted and modified from a review by Kelsall and Simpson (1991). In seeking means of reducing motor vehicle accidents involving ungulates, there seems to be consensus that fences offer the best solution in most cases. Standard ungulate fencing consists of 2.4 m tall woven wire (page wire) fencing. Since deer are adept at crawling under fences, gaps should be less than 23 cm, and bottom wires must be tight and hug the ground. Even minor washouts may provide passage. In order to be effective, the fence must be well maintained and damage caused by vandals or blown-down trees must be promptly repaired. The fence should be installed so that its effective height is not compromised by irregularities in the ground, e.g., on steep slopes or in ditches, as deer will jump (even high fencing) if the terrain favours them with hummocks or sloping hillsides from which to take off. Ungulates will be less apt to penetrate fences if they are erected close to highways to exclude attractive, vegetated ROWs. However, highway-fringing fences may provide unwanted maintenance or aesthetic problems. Puglisi et al. (1974), and others, have shown that deer mortality occurs most often when fences fringe, or are within 27 m of, cover-providing woods. Fences that are inside such woods, having little herbaceous cover, are relatively effective. To minimize a demonstrated tendency of ungulates to walk onto highways around the ends of fences, fence ends should be angled toward the highway, never away from it. Where possible, fences should end at bridges or other obstacles, in water bodies, or in areas as distant as possible from natural cover.

One-way gates allow passage of ungulates in one direction only, and are also useful in allowing pedestrians to cross the fence line. It is inevitable that ungulates will sometimes get onto a fenced highway either by penetrating or jumping the fence, or by walking around the ends and becoming trapped. Gates should be located strategically; close to off-highway cover, near places where moose and deer are apt to become trapped, and as far from the highway as possible.

One-sided fences are installed along only one side of the highway. They are used where animals move in one direction or where most animals are found on one side of the road. One reason that one-sided fences work well is that animals on the road can return to cover on the unfenced side with no obstruction. The cause of many accidents on fenced highways is that once inside, the animals panic and run back and forth between the fences, which greatly increases their chance of being hit. Adequate exit opportunities (one-way gates) are therefore an essential element of any highway fencing project.

Two-sided fences are installed along both sides of the highway. One-way gates are a necessary component of two-sided fences in order to provide exits for animals which accidentally access the fenced corridor through fence damage or over snow. Two-sided fences are used where animals are crossing in both directions and where there are many animals on both sides of the highway.

The data shows that short sections of fencing and fencing on one side only were as successful in reducing collisions as fencing on both sides. In controlled comparisons, the highest success noted (86% fewer collisions) was actually recorded for two one-sided fences which extended over longer distances (3.5 and 7.7 km respectively), (Reed et al. 1979). On the Coquihalla Highway, which was fenced for the entire length on both sides, the exclusion rate was about 93% (Simpson and Gyug 1991).

5.2.1.2 Methods of Wildlife Habitat Management

There are several methods of wildlife habitat management that are appropriate for use in the Park, either alone or in combination. Each method differs in risk, speed of transition, aesthetic characteristics, time to perform, and cost. Fire, small-scale tree falling and changing right-of-way treatments are suitable methods for managing wildlife habitats in the Park.

Fire

Fire is useful for transforming large areas to an early seral stage in an inexpensive manner. Fire cannot be used to treat small areas to maintain complexes with the small forage-producing openings needed to provide high value ungulate habitats. Fire may prove to be useful in areas where reduced fuel loading and insect damage control are also needed. Fire can also be used to create a variety of age classes and to add structural diversity of the landscape. The benefit of using fire is that it can produce valuable habitat and is inexpensive. The disadvantages of fire are the need for large treatment areas, control difficulties, the risk to Park facilities and visitors, and unfavourable public perceptions.

Small-scale tree falling

Small-scale tree falling can involve the partial or total clearing of the site through falling and burning. Small-scale tree falling can be used to effectively create small forage-producing openings, and to increase the snow interception cover and visual cover of an area. Small-scale tree falling allows for the preservation of advanced shrub and conifer seedling regeneration which are important in providing cover and also serves the dual purpose of forage and fire break. Small-scale tree falling should be used in areas where structural and age class diversity are needed but prescribed burning is inappropriate. In areas where this method is used to restore habitat, the debris should be removed to allow for maximum ungulate utilization. Sites with large amounts of debris have reduced suitability for ungulate use. Small-scale tree falling will also allow Park officials to identify trees to be saved to provide for other wildlife values (snags and nest trees).

Herbicide application

Herbicide application can be used to selectively remove unwanted vegetation and can be used to remove favourable wildlife vegetation from transportation corridors to discourage use by wildlife. However, BC Parks Conservation Program Policies (1997) favour biological, mechanical, or design methods of control rather than the use of chemical herbicides. Any use of herbicides would require the completion of an impact assessment. The use of herbicides must be judiciously planned and carried out to ensure that only those species targeted are affected. Use of herbicides near streams, rivers, wetlands or lakes should follow guidelines set forth in the Forest Practices Code (BCMOF 1995). Restrictions on the use of herbicides may limit their use for habitat management purposes. Herbicide application will be most beneficial when combined with small-scale tree falling and when used in areas where the presence of wildlife is to be discouraged.

Girdling of trees

Girdling of trees involves removing a band of bark across the cambium from around the tree. This destroys the trees' means of distributing nutrients and results in death. Girdling of trees is effective in areas where physical removal of trees is not appropriate. Girdling is not recommended as a method of removing trees from a large area because standing dead trees increase the area's vulnerability to fire and insects and continue to shade understory vegetation. Girdling may be used in combination with other methods to create wildlife snags and in environmentally sensitive zones e.g., riparian zones, where selective small scale tree removal is required for habitat goals.

Vegetation management

There are a number of possible vegetation management approaches that can be initiated to reduce the attractiveness of ROW vegetation for wildlife. Mowing of grasses allows them to grow taller and mature and, in doing so, become less attractive to wildlife. Fertilizers should not be used since they also increase the productivity and palatability of vegetation to ungulates. During snow plowing, "winging-back" of snowbanks leads to early green-up of the strips of exposed vegetation immediately adjacent to the roadway (Poll 1989). As a result some of the most attractive early-spring habitat for ungulates is produced within a metre of traffic. Discontinuing this practice, or raising plow blades so a layer of hard-packed snow remains at the roadside, are possible solutions (Brown and Ross 1994). These methods are relatively inexpensive and have the potential, when combined with habitat management, to effectively move wildlife away from the Travel Corridor. Alternatively, chemical repellents could be used (see below).

Planting of unpalatable species applies primarily to the ROW along the Travel Corridor and involves replacing existing vegetation with vegetation that is unpalatable or less palatable to ungulates than the present vegetation. Palatable ROW vegetation consists of grasses and forbs. Unpalatable right-of-way vegetation would consist of woody ground cover. This, in combination with the Travel Corridor Management Zone, could be highly effective in encouraging ungulates to move off the Travel Corridor into the managed habitat. Replacing existing ROW vegetation may help to deter animals from coming onto the ROW to feed, and in doing so, can reduce wildlife vehicle collisions. Leedy and Adams (1982) discuss the dilemma of the highway manager in some detail. On one hand ROWs must be well vegetated for aesthetic reasons and to guard against erosion. On the other hand there is a need to reduce the possibility of accidents between vehicles and ungulates. Leedy and Adams (1982) advise against selecting plant species attractive to large animals for seeding or planting, and recommend that attractive species be removed or replaced. Unfortunately, both these may be difficult to accomplish since deer, in particular, will browse and graze on a wide variety of vegetation. Elk are also relatively catholic in diet. In addition, the food preferences of large animals tend to vary between geographic areas. Where vegetation is necessary to controll erosion, very slow-growing grasses with low protein content are suggested as being less attractive to ungulates (A. Harestad personal communication). Other non-attractive plant species include kinnikinnick and coarse grasses. Clover and bluegrass should be avoided. Vegetation management should be combined with one or more of the above habitat management techniques for best results.

Use of chemical repellents

Brown and Ross (1994) conducted a thorough investigation into the use of chemical repellents for deterring wildlife from high risk areas. They concluded that some repellents may be effective in deterring wildlife, but caution that the cost of application may preclude their use over large areas. Effectiveness of any repellent can not be predicted without extensive, and costly testing. At least two applications of repellent, per month, are needed to maintain maximum effectiveness. Brown and Ross (1994) provided the following cost estimates of repellents they thought would be most effective:

Deer Away (powder)	$4400/application / 0.5 km
Hinder (liquid)	$1500/application / 0.5 km
Lithium chloride (granular)	$1800/application / 0.5 km

Widespread use of repellents to deter wildlife from using the Travel Corridor is not recommended. Selective use of repellents may be effective in forcing unwilling ungulates into managed habitat off the Travel Corridor.

Future plans for prescribed fire, insect control or habitat management within the Park should seek to create habitats attractive to wildlife which will serve to reduce their use of the highway corridor. For deer and elk, key habitats include spring and summer range which produce succulent ground forage (herbs and grasses) particularly from May to July. These areas include wetlands and small openings in forests with southern exposures and suitable soil depth and moisture. Moose will also frequent those habitats but their key forage species is shrubs, especially willow and red-osier dogwood. Those species tend to be associated with moist lower slopes in mixed deciduous forests.

5.2.1.3 Other Approaches

Wildlife mortalities as a result of collisions with vehicles and trains are a serious problem in the Park. At this time, the number of roadkills is stable but, if traffic loads increase significantly, wildlife roadkills will also increase. The major reasons for the high roadkill in the Park are:

i) The Travel Corridor bisects moose winter ranges and passes close by several ungulate summer ranges. Animals using the winter ranges or travelling to and from the summer ranges are being killed.
ii) Deer appear to be using the right-of-way heavily in the summer and spring months in the green up period. Low winter roadkills indicate that there may be little use of the small winter range areas along the highway.
iii) Salt applied as a de-icer provides an easily obtainable source of salt, contributing significantly to highway mortality.
iv) The plowed highway and railway rights-of-way provide easy travel corridors for wildlife to use in the winter.

Management programs should seek to increase wildlife use in areas removed from the Travel Corridor and decrease the attractiveness of ROW forage to ungulates. Such programs will help to reduce the use of the highway area and aid in preventing wildlife/vehicle collisions. Fencing is the most effective means of keeping animals off the ROW, but it is costly and requires costly yearly maintenance.

5.3 Forest Fire

5.3.1 Development of Fire Management in BC Parks

Historically, it has been the policy of the provincial government to suppress all wild and human-caused fires within provincial parks and recreation areas. In the mid 1960s, BC Parks, in consultation with BC Environment utilized prescribed and wildfire for the benefit of improved wildlife habitat in Wells Gray Provincial Park. Uncontrolled wildfires were subject to an uncontrolled fire attack plan. This plan ensured that fires provided acceptable benefits to wildlife and, at the same time, minimized risks to other values impacted negatively by fire.

Traditionally, fire management in provincial parks has been the responsibility of the Ministry of Forests. In 1997, BC Parks developed fire management policies for provincial protected areas (BC Parks 1997) and in 1998, a Memorandum of Understanding for Fire Management within Parks Management Areas and Adjacent Lands (BC Parks and Ministry of Forests 1998) was signed off between BC Parks and the Ministry of Forests.

Increased public concern regarding the conservation mandate of provincial parks necessitates a greater commitment to fire management. The U.S. National Park and Canadian National Park systems have been developing fire management plans, for most major parks, since the 1970s. A much better understanding of vegetation and successional processes which drive biological change within the Park will be required if successful vegetation management strategies are to be implemented.

Since the completion of this plan, two fires of lightning origin have been allowed to burn in the Natural Zone. In 1996, a 205-ha fire burned in the Upper Fraser River north of Brule Mountain and in 1998, a 2500-ha fire burned in the Moose River/Colonel Creek/Upright Creek area. The Moose fire is being considered as a potential site for revegetation studies with the Foothills Model Forest.

5.3.2 Fire Management Approaches

Management approaches and options related to forest fire management can be grouped into four categories based on location of park facilities and structures, human safety, rare and endangered species, wildlife management objectives, ecological and successional processes. A discussion of each of the four approaches follows.

5.3.2.1 Natural Wildfire

The wildfire "natural" approach allows fires to burn under natural conditions with no intervention. This approach is only feasible in those situations where fire does not endanger or threaten other Park values, or ecosystem values that extend beyond the boundaries of the provincial park, and where other management constraints are not a concern. Fires which are managed under this approach will be limited in their extent, by topographic boundaries, will have an overall beneficial biological impact, and are considered desirable within the overall objectives of the ecosystem management plan.

5.3.2.2 Prescription Wildfire

The prescription wildfire approach allows fires to burn under pre-established prescription guidelines. Each fire will be independently evaluated to determine if the fire meets conservation goals and objectives. All non prescription, human- caused fires will be suppressed. All fires will be subject to strict prescription guidelines based on codes of the Canadian Forest Fire Weather Index System. Fires considered to be managed using this approach will not pose a significant threat to human safety, developments, adjacent land jurisdictions, or unique ecosystems where fire is considered undesirable.

5.3.1.3 Prescribed Fire Approach

The prescribed burning approach allows burning of undesirable fuel types, potential pest outbreak stands, fuel accumulations, and restoration of wildlife habitat under controlled conditions. Prescribed fires may be desirable in portions of the Park where wildfire is not appropriate within the identified management constraints. All prescribed burns must be conducted in accordance with an approved Prescribed Burn Plan which will follow an established format of the BC Forest Service. Burn prescriptions should be based on the Canadian Forest Fire Weather Index (FWI) System, and the Canadian Forest Fire Behaviour Prediction (FBP) System.

5.3.1.4 Fuel Reduction or Manipulation Options

In situations where any form of burning is undesirable it may be necessary to treat an area through mechanical methods, or by manipulation of stand structure and tree species composition. This approach may be applied where a stand type poses a significant fire hazard, rare or endangered fauna or flora are threatened by competing vegetation, and/or when stand attributes do not meet current management objectives. Stand manipulation treatments can include chipping of downed surface fuels, removal of standing dead fuels (snags), and spacing and pruning in areas where high stand density is considered a hazard.

5.4 Mountain Pine Beetle and Spruce Beetle

The distribution of MPB stand hazard classes as outlined in section 3.5.1.4 shows how beetle infestations would likely progress once established in one of the zones within the Park. Prior to designing and implementing management programs or making decisions regarding control, the risk of infestation or outbreak should be quantified. Risk is a function of both the susceptibility to attack (hazard ratings) and the population level of beetles (beetle pressure), particularly in adjacent stands. Sufficient numbers of beetles can kill large numbers of trees irrespective of stand susceptibility. For example, infestations in lower hazard mixed stands containing white pine may result in higher beetle pressures on adjacent stands due to an increased brood productivity relative to lodgepole pine.

The basis for management decisions regarding the Park requires an understanding of both stand susceptibility and beetle pressure before appropriate control tactics can be implemented. Presently, estimates for beetle pressure can only be obtained from detailed ground probes of infested areas. This interaction between beetle pressure and susceptibility clearly shows the need to employ a suitable annual survey method which ensures all infestations are detected before an outbreak begins. The success of most of the following control strategies depends heavily on early warning and employing tactics which are appropriately designed for the size of the infestation.

The following subsections describe control tactics for the MPB, although the same tactics may be generally applied to the spruce beetle as well (except where otherwise noted).

5.4.1 Control Methods

Forest managers and researchers in British Columbia and the Pacific northwest have developed and tested various control tactics against the MPB in stands of lodgepole pine (Safranyik et al. 1974; Cole and Amman 1980; McMullen et al. 1986). Under the appropriate circumstances, many of these tactics are effective in mitigating the impact of the MPB. In British Columbia, the Ministry of Forests has attempted to incorporate all appropriate tactics into an integrated set of strategies designed to protect all forest values. The following is a summary of the tactics and strategies as recommended by regional forest health personnel in the Ministry of Forests (Safranyik and Hall 1990).

Tactics are generally chosen to meet specific resource emphases and are often integrated within and between stands. Some tactics are designed for small groups of infested trees and aim to preclude a major infestation. Others aim to control the rate of spread of existing infestations. Tactics also exist which attempt to minimize the risk of infestation. Following is a discussion of the more appropriate tactics, listed by Safranyik and Hall, which could be used in Mount Robson Provincial Park.

5.4.2 Survey and Detection

Survey and detection are the foundations of the program. Effective control actions can only be implemented if a problem is promptly identified and located. All management decisions should follow some form of survey and detection. The survey and detection program for the Park should be designed from the basis of the hazard rating profile for the pine stands to be surveyed. Aerial overview flights, sketch maps, oblique and vertical aerial photography and ground surveys or detailed probes comprise the survey and detection function. Actions may include the marking of trees, for single-tree or spot treatments, or boundary marking to facilitate tree cutting in larger infested areas.

5.4.3 Single-Tree and Spot Treatments

Single-tree and spot treatments are designed to control bark beetle populations when the problem is small. This will likely continue to be the preferred treatment tactic for managing infestations within the Park. These treatments consist of:

- fall and burn
- pesticide application (MSMA); and,
- debarking.

These tactics may be used on their own or in conjunction with pheromone baiting to contain expanding populations. For spruce beetle control, pheromone baits may also be used, however, fallen "trap trees" which are later debarked are often more effective for removing small infestations. Future successes will be determined by the ability to quickly detect and remove small groups of infested trees within high hazard stands.

5.4.4 Bait and Burn

The use of prescribed fire as a management strategy for restoring wildlife habitat and other values presents an opportunity to use this tool for forest health purposes as well. Burning was used successfully in a controlled trial in 1987 to remove a MPB infestation near Smithers, BC (Stock 1989). In June of the year in which a burn is planned, stands could be baited with pheromone to attract and concentrate nearby MPB or SB populations. These stands would then be burned in the fall, killing the brood beneath the bark.

In order for this tactic to be successful, however, the following points should be thoroughly considered:

- pheromone baits should not be expected to attract beetles from long distances, therefore this tactic would be most successful in areas with existing infestations baited trees must be burned, debarked or removed before the following summer. Failure to do so may increase beetle populations rather than control them; and
- burning of all baited trees must be thorough and confirmed by ground surveys in order to kill beetle brood under the bark. Beetles will likely survive in lightly burned trees. As well, uninfested trees which are lightly burned may become weakened and infested in the following year.

While this tactic holds promise, it is still in the experimental stages and should be used only with caution and careful planning.

5.4.5 Silvicultural Treatments

Silvicultural tactics can also mitigate the impact of MPB, although the benefits accrue over a long-term period. A comprehensive and integrated silvicultural program for young stands should minimize the threat of future infestations (Safranyik et al. 1974; Cole and Amman 1980; Cole 1985; Cole and McGregor 1985). Thinning to promote vigour will ensure that mature, highly susceptible trees will not be as predominant in the future. Enhancing species and age class mosaics will also minimize the extent of future infestations. The older high hazard stands within the Park may not be suitable for these tactics however, younger stands which are likely to have higher hazards as they age may be suitable candidates in high risk zones within the Park.

5.4.6 Strategies and Tactics

The implementation of any of these tactics would generally require that they be applied within a developed strategic framework. Strategies are generally chosen for specific management goals within specific management units where the protected areas and neighbouring values have been identified. The strategy may be to either; suppress, keep low, hold, abandon, or do nothing.

Suppression is an aggressive strategy which generally requires the rapid removal of infested trees within specified management zones. Specified areas within the Park where the hazard is high and MPB damage tolerance is low should be managed under an aggressive suppression strategy. The management unit may be as small as a single stand along a roadside pull-out or, as extensive as the upper reaches of the Moose River.

A 'keep low' strategy is usually designed to hold an impending outbreak in check for some defined period while other factors which may mitigate the risk to a threatened value are allowed to come into play. For example, the upper Fraser River zone may be an area where MPB infestations could be tolerated if they do not threaten the values adjacent to the Park. A 'keep low' strategy could be implemented indefinitely whereas holding actions are usually designed for a short period delay when an epidemic is imminent.

There are not likely many situations which could arise in the Park where a holding action would be an appropriate strategy. If, however, an outbreak were to prove imminent on the eastern boundary and suppression was not a feasible strategy, then holding tactics may be required to buy time so Jasper National Park managers could prepare for the impending infestation.

Abandon or 'do nothing' strategies are applicable when the expected mortality and beetle pressure risks are insignificant relative to the values emphasis. In the Park, where natural processes are emphasized, doing nothing could be the preferred strategy whenever the risks are properly quantified. Further detailed stand data should be collected to more accurately quantify the hazard in stands where this strategy is being considered. Very small pockets of high hazard trees surrounded by low hazard or continuous areas of low hazard stands could be allowed to become infested with minimal risk to other management zones. This strategy may also be implemented when management efforts would likely be ineffective in attaining the management objectives.

6.0 Summary

In order to verify much of the information presented in Part 1 and to put forth a more in-depth overview of the management issues faced by the staff of Mount Robson Provincial Park, a week of field studies were carried out during the 1995 field season. The predominate issues such as fire, forest health and wildlife concerns, as well as rare and endangered species were studied at length and resulted in an Ecosystem Management Plan providing BC Parks with a more holistic management approach and giving consideration to important adjacency issues and identifying future information needs and actions.

Part 2 Ecosystem Management Plan Recommendations

1.0 Introduction

1.1 Background

Part 2 presents an Ecosystem Management Plan for Mount Robson Provincial Park (the 'Park'), and is based on an ecological inventory and discussion of management options presented in Part 1: Background and Management Issues. The initiative to develop the plan is based on the identification of management objectives in the Park Master Plan (BC Parks 1992). The Master Plan (BC Parks 1992) identified the need for a long-term vegetation management plan to address:

- the identification of regionally and locally important plant communities;
- forest resource inventory, including forest types, the occurrence of rare plant species and sensitive plant communities;
- wildlife habitat inventory, including critical winter and summer range;
- fire suppression and management, including an assessment of fire history;
- management of disease and insect outbreaks;
- vegetation management along the Travel Corridor, including prescribed burning;
- land uses in adjacent areas; and
- protection of key forest and vegetation values, by the application of sensitive management techniques.

Part 1 of the Ecosystem Management Plan provides a general ecosystem overview of the Park, summarizes ecosystem inventories into a PAMAP GIS framework, and discusses important management issues and options presented in the Ecosystem Management Plan for the Park. Ecosystem mapping at 1:50 000 for the Park has been completed by Lea and Maxwell (1993), and this data was integrated with 1:20 000 forest cover and TRIM mapping provided by the Ministry of Forests in PAMAP GIS format. GIS themes were used as the baseline data for providing an inventory of forested and non-forested communities, evaluating wildlife habitats, assessing mountain pine beetle and spruce beetle hazard, and for describing fire history and the relative fire hazard of forest stands in the Park. The approach taken by the team was to identify issues and prioritize actions for biodiversity conservation, forest fire, forest health, and wildlife issues, and to integrate these into an overall ecological context using the GIS-based ecosystem information.

1.2 General Management Goal

The general ecosystem management goal for the Park is to provide an area for the conservation of biological diversity of natural forested and non-forested ecosystems, and, as much as possible, to permit their natural ecological processes to occur unchecked. A completely 'no action' management approach will be constrained by:

- conservation of biological diversity: protection of critical and important wildlife habitats, habitats of endangered/threatened plants and animals, important old forest areas, other ecologically-significant vegetation and animal features as they are identified, and maintenance, or creation of target seral stage distributions;
- adjacency issues: consideration of management objectives of neighbours such as Jasper National Park and the Robson Valley Forest District and for protection of ecological values, public safety, wildlife movements into and out of the Park, and adjacent forests; and
- recreation management objectives: including visitor safety concerns, protection of cultural heritage values, maintenance of water quality, and considerations for viewscapes and other perceived aesthetic factors.

1.3 Ecosystem Management Zones

The influence of the above-mentioned constraints on management approaches will vary in different regions of the Park. To account for this variability, the Park has been divided into four Ecosystem Management Zones (EMZs). EMZ boundaries for the Park are shown in Figure 14. EMZ boundaries have been chosen so that they:

- encompass areas which have a similar combination of management constraints, and thus a consistent vegetation management approach can be developed and applied,; and;

- have boundaries based on prominent landmarks such as lakes, rivers or topographic breaks, to ensure rapid ground identification.

1.4 Evolution of the Management Plan

Management strategies combining active and non-active approaches are put forward here for each of the EMZs, depending on the list of constraints identified for each of them. The collection of information on Park ecological values and processes is presently incomplete and should be ongoing. Management policies presently developed and presented here should be altered in light of new understanding or interpretations. Thus, for each of the EMZs, new management constraints may be added, or existing constraints may be removed, as the knowledge base increases, and as management policies evolve. The precise boundaries of the EMZs may also be refined as more detailed information becomes available.

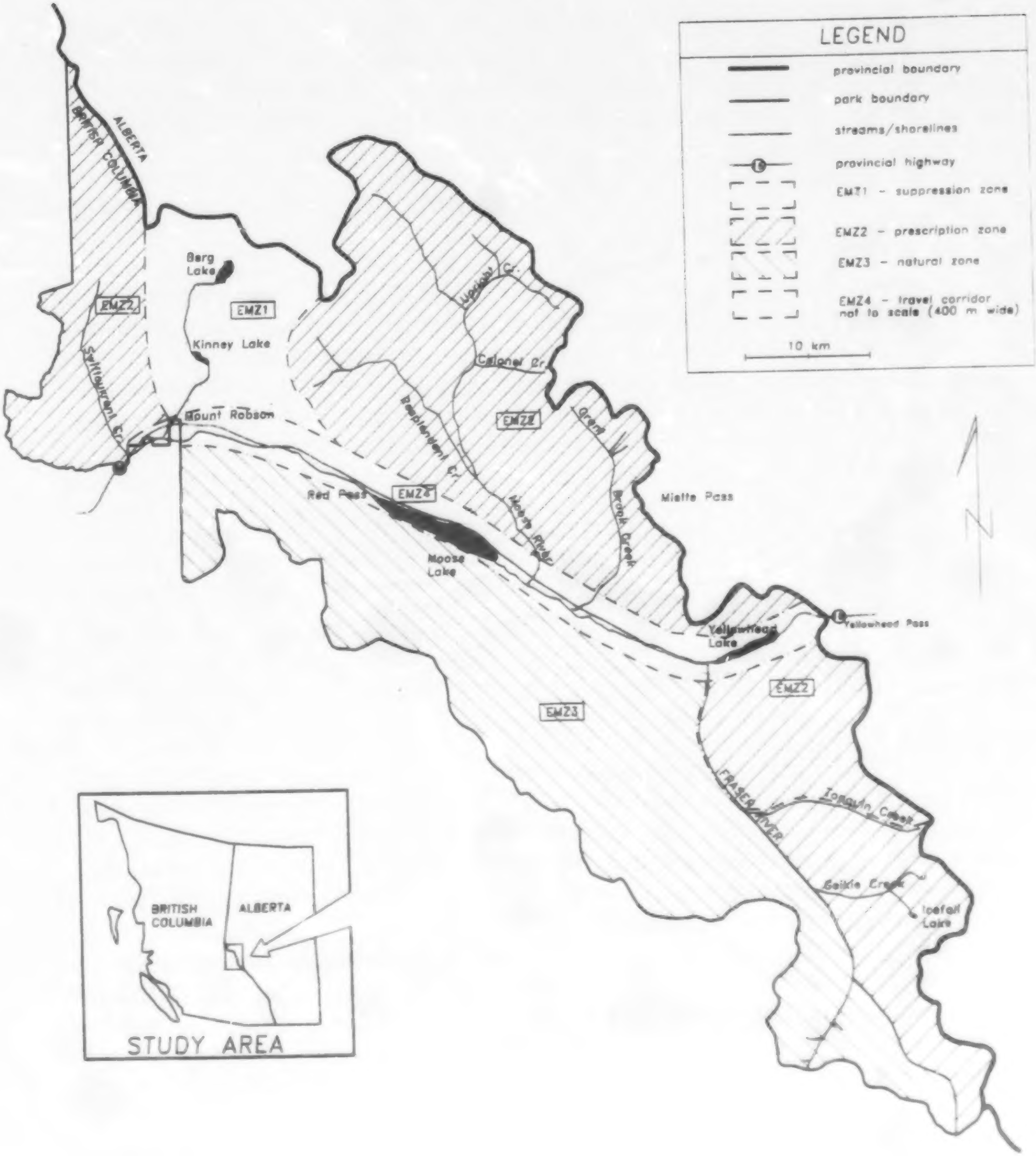

LEGEND
provincial boundary
park boundary
streams/shorelines
provincial highway
EMZ1 - suppression zone
EMZ2 - prescription zone
EMZ3 - natural zone
EMZ4 - travel corridor not to scale (400 m wide)
10 km
ALBERTA
BRITISH COLUMBIA
Berg Lake
EMZ2
EMZ1
Kinney Lake
Swiftcurrent Cr.
Mount Robson
Upright Cr.
Colonel Cr.
Resplendent Cr.
EMZ2
Grant
Brook Creek
Miette Pass
Red Pass
EMZ4
Moose River
Moose Lake
Yellowhead Lake
Yellowhead Pass
EMZ2
EMZ3
FRASER RIVER
Tonquin Creek
Geikie Creek
Icefall Lake
BRITISH COLUMBIA
ALBERTA
STUDY AREA

Figure 14. Ecosystem Management Zones for Mount Robson Provincial Park

2.0 Overview of Management Issues

It was stated above that the principle objective of vegetation management in the Park is to permit natural disturbance regimes such as fire and beetle epidemics to proceed unimpeded, and that such an objective is constrained by a host of factors that vary in different areas of the Park. To deal with this general objective and its constraining factors, management objectives and actions are summarized within the categories of conservation of biodiversity, and management of forest fires, forest health issues, and wildlife populations.

2.1 Biodiversity Conservation

A major objective of any provincial protected area is to provide an area for conservation of biological diversity or 'biodiversity.' Biodiversity refers to not only the complete list of plants and animals that comprise protected area ecosystems, but also the ecosystems themselves, as well as the dynamic ecological processes that maintain and define them. The Park encompasses four biogeoclimatic zones from sub-montane to alpine elevations, and supports a variety of forested and non-forested ecosystems, an inventory of which was described in Part 1, Section 3.0. Of special interest are any rare or endangered plant and animal species that may occur in the Park. At the present time only a cursory examination of Park flora has been completed, and this is identified as a major knowledge gap for carrying out the management plan.

For the purposes of biodiversity conservation, a 'natural' distribution of seral stages across the Park landscape should be maintained. Any active management strategies employed to meet this objective should be preceded by a survey of rare and endangered plant and animal species in the area to be managed.

2.2 Forest Fire

Forest fire is the most effective disturbance agent determining the age class structure and species composition of forests in the Park. At low elevations, extensive burning during the period of railway construction in the early 1900s has resulted in a large and continuous even-aged stand of lodgepole pine from east to west across the Park. The continuous age class and stand structure of this stand has been maintained to some degree by a policy of fire suppression. As a result, the distribution of seral stages and species composition in these stands does not represent a natural pattern, but one strongly simplified by high numbers of ignitions over a short time period, and an ongoing policy of fire suppression. In most other areas of the Park, the present distribution of seral stages is considered to represent a relatively natural distribution, although fire suppression has probably increased the extent of Old Forest ecosystems which might otherwise have burned.

Forest fire management in the Park should aim at permitting natural fire cycles to occur over as wide an area of the Park as is possible. Where such an objective is constrained, active management approaches such as prescribed burning, prescription wildfire, or mechanical treatments will need to be employed to recreate natural disturbance patterns in a relatively controlled manner. The application of the fire management approaches outlined in the report will require considerable expertise for implementation of the plan.

2.3 Forest Health

As for forest fire, epidemic outbreaks of bark beetles are a natural process that have the potential to significantly alter the forest landscapes over wide areas of the Park. The even-aged lodgepole pine stands described above have the potential over the next 20-40 years to generate or carry a large mountain pine beetle outbreak, and this is the most serious forest health issue faced in Mount Robson Provincial Park. A bark beetle epidemic originating in the Park may spread to commercial forest land outside of the Park, and management efforts will have to assess all values before action is taken.

A number of strategies and tactics can be selected to reduce the spread of mountain pine beetle, depending upon site-specific factors such as pest incidence potential, stand hazard levels, infestation size and risk of spread, the probability of future outbreaks, and potential conflicts with other management objectives. Whenever possible, forest health management activities should be integrated with other management activities, so that the effects are mutually beneficial.

2.4 Wildlife

The management of park wildlife populations can be considered as a special subset of overall biodiversity conservation objectives. Habitats for wildlife populations are completely dependent on the distribution and composition of Park ecosystems. In addition to climatic and edaphic factors, the nature of ecosystems is determined in large part by both natural and man-affected disturbance factors operating within the Park. Thus management of wildlife habitats must be integrated with forest fire and forest health management policies to be effective.

Wildlife habitat management should focus on maintenance of the diversity of natural ecosystems and associated wildlife populations in the Park. Because of the major human-caused disturbance (forest fires) during construction of the railway, some effort should be made to re-establish old forest stands, which would probably be more abundant today if the railway had not been constructed through the Park. The even-aged forest stands, which cover a large area of the Park, are developing some of the important characteristics associated with mature and old forests, such as snags, coarse woody debris, and arboreal lichens. Habitat management should ensure that Old Forests are protected in representative habitat classes throughout the Park to re-establish a more natural age class distribution.

3.0 Management Objectives and Actions within Ecosystem Management Zones

The Park was divided into four ecosystem management zones - the Suppression Zone (EMZ1), the Prescription Zone (EMZ2), the Natural Zone (EMZ3), and the Travel Corridor (EMZ4), based on criteria developed in Part 2, Section 1.4 (Figure 14). Management objectives and actions specific to each of the zones are described in this section. Management objectives and actions relevant to the Park as a whole are described in Section 4.0.

3.1 Suppression Zone - EMZ1

The EMZ1 is bounded by the Swift Current drainage to the east, the Travel Corridor to the south and a boundary running north - south from the Coleman Glacier. The EMZ1 includes the ESSFmm, SBSdh, and ICHmm subzones. A policy of letting natural disturbances occur unchecked in this zone is complicated by public safety issues, visual objectives, and the relative rarity of old forest stands in the SBS and ICH zones in the Park. The overall management approach in the Suppression Zone is to action and extinguish all fires as rapidly as possible, and to provide bark beetle hazard assessments so that potential outbreaks can be monitored and management action taken if required. A policy of full suppression is compatible with the objectives of wildlife habitat management and biodiversity conservation for the zone.

Table 15 provides a synopsis of management actions and relative priorities for the Suppression Zone.

3.1.1 Biodiversity Conservation

A policy of attempting to fully suppress all fires in this zone will result in the aging of the relatively young, even-aged stands that dominate the zone at this time. The majority of stands in the Suppression Zone are young forest stands that have regenerated following fires associated with construction of the railway through the Park. It can be expected that, if the policy of full suppression is successful, then, through the processes of forest succession, young forest stands will change to mature forest and eventually old forest stands dominated by Douglas-fir in the SBS zone, and by western redcedar and western hemlock in the ICH zone. Such old forest ecosystems are rare in the Park, and thus full suppression of fires is desirable for the objectives of biodiversity conservation. As discussed below, succession to old forest stands in this zone is complicated by forest health issues.

3.1.2 Fire

This zone is heavily used by hikers and climbers to access the Berg Lake trail system. Given the importance of this area to recreation, the most appropriate action within this zone is to suppress all fires. It is considered an important objective to maintain public safety and to manage scenic and recreational values associated with the trail system. This is a major focal point for tourists, climbers, and hikers in the Park, and access is concentrated in the valley bottom. Evacuation in the event of fire would be difficult, and the potential impacts on the aesthetic and recreational quality of the area is considered unacceptable.

Table 15. Synopsis of management objectives, actions, and relative priorities in the Suppression Zone (EMZ1)

Management Issues	Objectives	Action	Section Reference (Part 1)
Biodiversity conservation	1. Re-establish relatively Old Forest stands in the ICH and SBS areas of the zone	• Full fire suppression as discussed below	2.3; 3.0
	2. Determine the extent and locations of rare or endangered plant and animal species, or special ecosystems	• Conduct an inventory of rare and endangered species and habitats within the zone (preliminary conducted in 1999) • Develop procedures for conserving identified species as required	5.1
Fire	1. Prevent fire from destroying Park structures, imperilling Park visitors, escaping into adjacent jurisdictions, and destroying rare Old Forest types	• Contain, confine and/or control all fires within this zone	3.4.1; 5.3.2
	2. Reduce the probability of fire damage to important Park developments and facilities	• Develop a fuel hazard reduction plan for the areas surrounding important facilities and structures	5.3.2
	3. In stands considered to pose a significant risk or hazard to facilities and/or ecosystem integrity, lower the potential for large-scale uncontrolled fire by altering surface fuel loading and/or manipulating stand structure and age class distribution	• Survey stand fuel loadings and establish fuel monitoring plots in those areas deemed to have high fire danger relative to park resources • Immediately assess the fire hazard of significant blowdown areas as soon as possible after it occurs	5.3.2.4
	4. In conjunction with other agencies (Forest District Protection Staff, CFS fire specialists) assess and evaluate the most reliable and effective active management approaches	• Develop a program to assess the feasibility and efficiency of active management options including: removal of surface and standing aerial fuels, including chipping of downed coarse woody debris; removal of standing dead fuels (snags); and spacing and pruning in areas where high stand density is considered a hazard • Prescribed burning of fuel accumulations under controlled conditions • Low intensity surface burns that can be prescribed to reduce overall stand hazard • Manipulation of stand structure and tree species composition to improve stand stability and reduce long-term fuel accumulations	5.3.2

Table 15 continued

Management Issues	Objectives	Action	Section Reference (Part 1)
Fire (continued)	5. Reduce the risk of human-caused fire	• Develop a hazard plan for all high visitation areas • Develop a public education program, especially for areas of high visitation and high fire hazard	5.3
	6. Improve public safety related to fire in high visitation areas	• Develop a comprehensive evacuation plan which addresses fire conditions	5.3
	7. Assess vegetation and other significant values outside of the Park and abutting EMZ1	• Conduct an inventory of the vegetation and resources abutting the Park to determine protection strategies, resources at risk, and to aid in the decision-making process	4.0; 5.1
	8. Improve monitoring of fire weather and fire information record keeping	• Establish and maintain a network of fire weather stations representing the diversity of climates within the Park; start with EMZ1 (installed in 1997)	5.3.2
Forest health	1. Assess potential for pest incidence	• Assess potential for pest incidence	1.3.4; 1.3.5; 3.5
	2. Refine and reassess hazard ratings	• Refine and reassess hazard ratings	
	3. Monitor outbreaks	• Monitor outbreaks	
	4. Evaluate the threat to Park management objectives	• Evaluate the threat to Park management objectives	
	5. Contain outbreaks which represent a significant threat to Park values and management objectives	• Single tree treatments or fall and burn, with or without pheromone baiting	5.4.3; 5.4.4; 5.4.5
	6. Decrease the probability of future outbreaks occurring in high hazard areas	• Thinning/silvicultural treatments to reduce stand susceptibility • Single tree treatments to remove spot infestations in high hazard areas	5.4.3; 5.4.6
Wildlife	1. Improve inventory	• Conduct inventories of wildlife populations in the EMZ	3.6
	2. Improve understanding of habitat utilization	• Study habitat use of important wildlife populations	3.6

Historically, fires have been less frequent in the ICHmm subzone, when compared with other areas of the Park. A large portion of this area was disturbed during the early part of this century consistent with the Travel Corridor. Historical fire evidence, in combination with the current age class distribution, indicates that successional processes will be relatively unimpeded in the absence of fire in this area for some time to come given the long fire regimes and recent disturbance this area has experienced.

3.1.3 Forest Health

Many of the high hazard stands for the MPB lie within EMZ1 (Appendix 6). This zone also corresponds with the areas of high use and visual impact in the Park. While a policy of fire suppression within this zone would preserve many other management objectives, it will also tend to exacerbate bark beetle problems. Because the high hazard stands in this zone originated from a fire disturbance, they are already even-aged and fairly homogeneous. As the stands age, the probability of a large-scale MPB infestation will continue to increase. Under these conditions, the MPB can play a similar ecological role as fire, sweeping through and killing large areas of susceptible pine, and leading to some of the detrimental impacts described in Part 1, Section 3.5.1.2. Beetle-caused mortality may also make it much more difficult to suppress future fires in this area and creates a different structure, disturbance, timing and nutrient cycling.

Management strategies within this zone should therefore be focused on early detection of bark beetle infestations, continued hazard assessment over time, and concurrent treatments if required. The fire suppression ranking for this zone conflicts directly and inescapably with the hazard and risk of MPB infestations in the future. When infestations do begin, the risk of spread to other areas of the Park or neighbouring areas will need to be evaluated. In some cases, the use of pheromone baits to contain and concentrate beetle populations in small localized areas, followed by individual tree fall an burn on-site (see Part 1, Sections 5.4.3 - 5.4.5) may be necessary to minimize this risk.

3.1.4 Wildlife

The eventual aging of the even-aged stands that presently occupy the Suppression Zone will result in mature forest and old forest stands with generally more desirable structural characteristics for wildlife habitat. At the present time canopies are more or less continuous, and subcanopy vegetation is relatively sparse. As stands age and canopies open, subcanopy vegetation will increase in coverage, tree layers will become more diverse, and this will be generally positive for wildlife habitat. The small-scale tree falling that may be required to deal with forest health issues will create stand-level structural diversity that will further increase the value of these sites as wildlife habitat. Given the low availability of old forest ecosystems in the SBS and ICH zones, aging of these stands will also provide important habitat for old forest dependent species such as several species of cavity-nesting birds, marten and fishers.

3.2 The Prescription Zone - EMZ2

This area includes the Moose River and Brock Creek drainages up to the Travel Corridor and the east side of the Fraser River down from Yellowhead Lake (Figure 14). A policy of allowing disturbance to proceed unchecked in the zone is constrained by the importance of certain old forest ecosystems as caribou habitat, and by the presence of certain lodgepole pine stands that represent a very high risk for originating a mountain pine beetle epidemic. Wildfires will be permitted in the zone under certain weather conditions, and in certain areas of the zone, as discussed below. It may also be necessary to use prescribed fires to reduce forest health hazard, and to achieve some wildlife habitat objectives for the zone.

Table 16 provides a synopsis of management actions and relative priorities for the Prescription Zone.

Table 16. Synopsis of management objectives, actions, and relative priorities in the Prescription Zone (EMZ2)

Management Issues	Objectives	Action	Section Reference (Part 1)
Biodiversity conservation	1. Determine the extent of rare or endangered plant and animal species or special ecosystems	• Conduct an inventory of rare or endangered species and special habitats within the zone (conducted in 1999) • Develop procedures for conserving identified species as required	5.1
Fire	1. Improve monitoring of fire weather	• Establish and maintain a network fire weather stations representing the diversity of climate within the Park • Establish a database with daily fire weather codes and indices relevant fire history information (installed in 1997)	5.3.2
	2. Improve strategies for visitor safety	• Develop a system so that, if fires are allowed to burn, visitor location information can be immediately accessed and rapidly incorporated into a decision to allow the fire to burn • Develop evacuation strategies for different areas of the Park, and for different fire scenarios	5.3.2
	3. Develop an understanding of fire behaviour for the fuel types present in this zone to develop realistic models of fire behaviour	• In cooperation with the MOF and CFS conduct research-level prescribed burns in selected areas; involve staff in the experiments and in the area of fire behaviour, so better decisions related to actioning or leaving fires can be made, given current and future predicted weather conditions	5.3
	4. Refine and develop a more comprehensive set of prescription guidelines	• In consultation with BCFS and CFS specialists, and based on research results from the Park and elsewhere, develop prescriptions which are better associated with fire behaviour patterns in the specific fuel types that occur in the zone (Moose River Prescribed Burn Plan, 2000)	3.4; 5.3

Table 16 continued

Management Issues	Objectives	Action	Section Reference (Part 1)
Fire continued	5. Inventory of values abutting the Park	• Conduct a general level inventory of important values in areas abutting the Park, and use this information to help in the decision to let fires burn	4.0; 5.1
Forest health	1. Assess potential for pest incidence	• Conduct aerial and ground surveys	1.3.4; 1.3.5; 3.5
	2. Refine and reassess hazard ratings	• Collect age class, diameter, and stand descriptive data to improve the accuracy of future hazard assessments • Reassess changing hazard profiles with time and following natural or human-made disturbances	1.3.4; 1.3.5
	3. Monitor outbreaks	• Conduct ground surveys and probes to assess population expansion	3.5; 4.0; 5.4
	4. Evaluate the threat to Park values	• Based on the results of objectives 1-3, determine if projected losses are acceptable in terms of stated objectives for the zone, Park values and the surrounding ecosystem	3.5; 4.0; 5.4
	5. Contain outbreaks which represent a significant threat to Park values	• Preferentially burn infested, high hazard stands • Use pheromone baiting with single tree treatments • Consider using "bait and burn" tactic (under carefully controlled conditions)	5.4.3; 5.4.5
	6. Decrease the probability of future outbreaks occurring in high hazard areas	• Use prescribed fire to encourage heterogeneous forest composition and structure • Use thinning/silvicultural treatments to reduce stand susceptibility • Use single tree treatments to remove spot infestations in high hazard areas	5.3.2 ; 5.4.3 ; 5.4.6
	7. Monitor and minimize negative impacts of prescribed burns on forest health	• Conduct ground surveys and monitoring of insect populations in burned areas • Encourage burns which create forest heterogeneity and do not predispose susceptible trees to attack	5.3.2 ; 5.4.2

Table 16 continued

Management Issues	Objectives	Action	Section Reference (Part 1)
Wildlife Subzone 1 Ungulate Summer Range	1. Maintain or increase the quality and quantity of ungulate summer range	• Maintain 60% (246 km^2) of the area in forest and maintain 60% of that forest as Old Growth • Any fires which threaten parkland forest should be suppressed	3.6; 5.2
Subzone 2 Caribou Winter Range	1. Identify the habitat requirements of wintering caribou (completed in 1998)	• Identify the specific characteristics of the forests currently used by caribou • Determine characteristics of use such as species use and seasonality	3.6; 5.2
	2. Maintain or increase the quantity and quality of caribou winter range	• Prescribed fire should be used to convert about 1/3 of the subzone to age class 1 in the next 150 years to ensure a sustained renewal of 300+ year terrestrial and arboreal, lichen-producing forests • Critical habitats should not all be converted to a young seral stage simultaneously • Before burning the most up-to-date lichen literature should be consulted, as knowledge on how to best regenerate terrestrial lichen-producing forests is lacking • Consultation with the fire management plan for Jasper National Park is necessary to ensure continuity of caribou habitat	3.6; 5.2
Subzone 3 Ungulate Summer Range	1. To maintain or increase the quality and quantity of ungulate summer range	• Use prescribed fires to create age class and structural diversity in the forest (no more than 1/3) should be burned at any one time	3.6; 5.2
Subzone 4 Biodiversity Conservation Area	1. Maintain the present combination of structural stages and deciduous-coniferous forests	• Permit wildfires to burn under prescriptions to be developed for the subzone	3.6; 5.2

3.2.1 Biodiversity Conservation

The Prescription Zone includes primarily the ESSFmm subzone, the AT zone, and a small portion of the SBSdh subzone. Montane and subalpine areas of the Prescription Zone are dominated by old forest ecosystems of the ESSFmm subzone and so provides an important area for conservation of forested ecosystems of this subzone. The SBS portion of the zone is dominated by continuous, even-aged young forest stands of lodgepole pine that regenerated following railway fires. Any prescribed fires should be preceded by a careful evaluation of rare or endangered species, rare old forest types, critical or rare habitats, and should consider the overall distribution of seral stages for the zone.

3.2.2 Fire

The restrictions on fire in this zone are directed at creating and maintaining optimal conditions for summer and winter caribou habitat. All nonprescription, lightning, and human-caused fires will be carefully assessed and monitored within this zone. All fires within the zone will be subject to strict prescription guidelines based on codes of the Canadian Forest Fire Weather Index System. Prescribed fires within this zone are not considered to pose a significant threat to human safety, park developments, and adjacent land jurisdictions where fire is considered undesirable.

Prescriptions for permitting wildfires in the zone will be developed in conjunction with Ministry of Forests and Canadian Forest Service fire specialists, based on research into fire behaviour in the fuel types that occupy the zone. It will be necessary to carefully monitor fire weather to achieve this objective.

3.2.3 Forest Health

As described above, and shown in the accompanying map of predicted fire history, submontane elevations in the SBSdh within the Prescription Zone are dominated by even-aged young forests of lodgepole pine. Portions of these stands are currently classified as moderate to high hazard for MPB, and, over the next 30 to 50 years, a large component of these stands will shift into the moderate and high hazard class. In the absence of disturbance the age structure and extent of this forest type make it highly susceptible to a future large scale outbreak of MPB, which has important implications both within and outside the boundaries of the Park.

To reduce the potential for epidemic levels of MPB developing in this zone, or for this zone to transport a MPB epidemic outside of the Park, a carefully planned prescribed fire, or series of prescribed fires, should be carried out. The principle objective of the prescribed fire plan is to break up the continuity of the single age class distribution within the zone, and, over time, to create a mosaic of age class types and species. The size and scope of this burning program would have to be large enough to create a buffer zone sufficient to limit or deter beetle population movements across it, but not so large that another area of even-aged lodgepole pine forest regenerates. Areas for burning should also be coordinated with wildlife objectives, as it would be desirable to break up the present even-aged structure of the existing stands. The value of prescribed fire approach is that fire effects can be controlled by detailed prescription development.

Stands in which to conduct the burn can be identified from the MPB hazard map (Appendix 6). A preliminary evaluation suggests that forest health and wildlife could be most appropriately met by burning stands on the eastern slopes of the Moose River, or those southeast of Moose Lake. These areas contain stands which will soon have very high potential for developing MPB outbreaks, and, because of their central location within the Park, will provide a buffer for insect attack from both the east and the west.

3.2.4 Wildlife

Woodland caribou, which regularly use the eastern parts of the Park, prefer Old Forest stands for both winter and summer range. Caribou are threatened in both British Columbia and Alberta, and considerable effort has been made in both provinces to protect and manage remaining populations. Generally, large contiguous areas of Old Forest are considered best for caribou, so management should emphasize protection from fire in areas used by caribou.

For the purpose of wildlife management the Prescription Zone is subdivided into 4 subzones, the boundaries of which are shown in Figure 15. Specific prescriptions for the subzones are given in Table 16.

Subzone 1 - Caribou Summer Range: Caribou summer ranges occupying about 439 ha along the eastern boundary of the Park in the Alpine Tundra and ESSF parkland.

Subzone 2 - Caribou Winter Range: This subzone represents caribou winter range in the Park, and is located around the Moose River - Resplendent Creek Valley junction (62 km^2). The majority of this zone is dominated by old forest, and there are approximately 8 km^2 of young forest stands (40-60 years) in this area.

Subzone 3 - Ungulate Summer Range: This subzone includes the upper watershed of the Moose River and is then delineated by the eastern bank of Resplendent Creek, Moose River, and the Upper Fraser River. This area covers about 120 km^2 and is used in summer by moose, deer, elk and goat.

Subzone 4 - Biodiversity Conservation Area: This subzone begins at the eastern boundary of Subzone 3, and extends to the Park boundary east of Yellowhead Lake. It is approximately 47 km^2 in size, and supports moose, deer, and elk summer range and a goat range. During field surveys of the Park significant ungulate sign was found in western end of this subzone. This area contains some of the greatest biodiversity in the Park due to the mix of coniferous and deciduous forests.

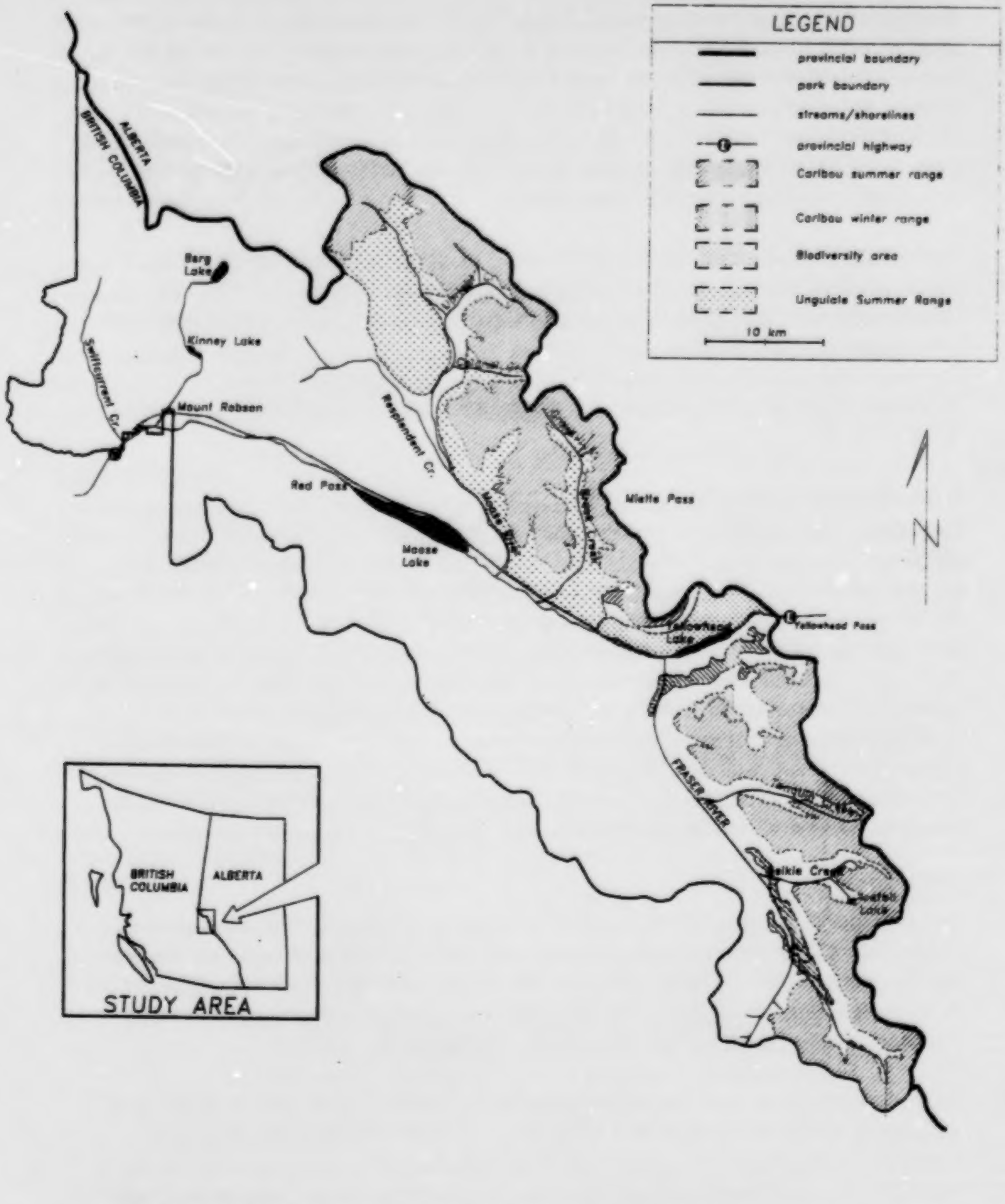

LEGEND
provincial boundary
park boundary
streams/shorelines
provincial highway
Caribou summer range
Caribou winter range
Biodiversity area
Ungulate Summer Range
10 km
ALBERTA
BRITISH COLUMBIA
Berg Lake
Kinney Lake
Swiftcurrent Cr.
Mount Robson
Resplendent Cr.
Red Pass
Moose Lake
Moose River
Miette Pass
Yellowhead Lake
Yellowhead Pass
FRASER RIVER
Geikie Creek
N
BRITISH COLUMBIA
ALBERTA
STUDY AREA

Figure 15. Subdivisions of the Prescription Zone - EMZ2 for wildlife

3.3 The Natural Zone - EMZ3

The Natural Zone includes the area south of the Travel Corridor and runs along the eastern boundary of the Fraser River south of Yellowhead Lake. Because of the low potential for fires or pest epidemics spreading out of the Park within these boundaries, the general management objective of preserving biodiversity and ecosystem processes can proceed relatively unconstrained in this zone. Consideration of unique ecosystems, rare old forest types, and rare or endangered plant and animal species will be the major management constraints to allowing natural processes to occur.

The boundaries of this zone are proposed based on topographic features that provide effective buffers to lands adjacent to the Park. With the exception of the Ptarmigan and Dave Henry creeks, fires ignited within this portion of the Park are predominantly contained by the surrounding topography.

A synopsis of management actions and relative priorities for the Natural Zone are provided in Table 17.

3.3.1 Biodiversity Conservation

Forests in the Natural Zone are predominately old forest stands within the ESSFmm and SBSdh zones. A small area of Young Forest associated with railroad fires occurs near the outlet to Moose Lake. Thus the Natural Zone represents a major repository of protected old forests for the biogeoclimatic units contained. At the present time large scale anthropogenic fires have not affected the zone, so that the present distribution of seral stages can be assumed to represent a relatively natural landscape mosaic. Not actioning fires in this zone will maintain a natural "benchmark" landscape and will result in a mosaic of plant communities that reflect natural levels of disturbance. The diversity and patch dynamics of this benchmark area could be compared to other areas. This policy should not be employed until an assessment of rare plant and animal species is completed, and ecosystems within the zone have been prioritized for conservation.

3.3.2 Fire

No fire suppression activities will be conducted within this zone unless fires are considered to pose a significant threat to adjacent areas within, and outside of the Park, or if a fire poses significant threat to human safety, developments, and unique ecosystems. Fires will be individually evaluated based on risk to other resources, location, and current fire weather conditions to determine if the fire meets conservation goals and objectives.

Currently, the proposed approach of not actioning wildfires does not include an upper limit prescription. Given the topographic boundaries, it was felt that the majority of this zone could be allowed to burn without imperilling adjacent areas. The exceptions would be the Ptarmigan and Dave Henry drainages which would require careful monitoring of a fire were to occur within this zone.

Codes and indices for the Canadian Forest Fire Danger Rating System were compiled for six weather stations adjacent to and in the vicinity of the Park. The data compiled from these (see Appendix 2) can be used to develop preliminary upper wildfire prescription limits. However, these six stations may not all be representative of fire weather conditions within the Park. (Since completion of this plan, two permanent weather stations have been installed in the Park.)

To further facilitate upper limit wildfire prescriptions development it is recommended that BC Parks work with both the Ministry of Forests Protection Branch and the Canadian Forestry Service fire management group.

3.3.3 Forest Health

Permitting wildfires to burn allows little control over whether the impact of fire on forest health is positive or negative (see Part 1, Section 3.5), therefore management practices in this zone should be focused on early detection and prevention of bark beetle infestations where a high hazard warrants. As far as possible, a conservative approach in actioning pest outbreaks in the zone should be taken so that the natural ecosystem function can be maintained.

3.3.4 Wildlife

The management approach of not actioning wildfires, and maintaining a conservative approach to pest outbreaks, will, in the long term, result in a relatively natural landscape mosaic in the Natural Zone. Such a management approach can be expected to maintain the present status quo of wildlife habitats in the long term within the zone. As for biodiversity conservation, an assessment of critical wildlife habitats within the zone should be conducted so that important Old Forest ecosystems with limited distributions within the zone are not changed to younger, less desirable structural stages.

Table 17. Synopsis of management objectives, actions and relative priorities in the Natural Zone (EMZ3)

Management Issues	Objectives	Action	Section Reference (Part 1)
Biodiversity conservation	1. Maintain 'natural' ratios of forest structural stages	• Monitor all wildfires and other disturbances, and update ecosystem inventory database	3.4 ; 5.3.2
	2. Determine the extent of rare or endangered plant and animal species or special ecosystems	• Conduct an inventory of rare or endangered species and habitats within the zone (conducted in 1999) • Develop procedures for conserving identified species as required	5.1

Table 17 continued

Management Issues	Objectives	Action	Section Reference (Part 1)
Fire	1. Improve monitoring of fire weather	• Establish and maintain a network of fire weather stations representing the diversity of climates within the zone (installed in 1997) • Establish a database with daily fire weather codes and indices and relevant fire history information	5.3.2
	2. Obtain the ability to understand and model fire behaviour for the fuel types present in the Park	• In cooperation with the BCFS and CFS initiate staff training in the area of fire behaviour so appropriate staff are prepared to make decisions related to actioning or leaving fires, given current and future predicted weather conditions (Brute Mountain fire in 1996)	3.4; 5.3
	3. Develop a better understanding of those ecosystems which require fire processes for maintenance within this zone	• Conduct more research on specific vegetation communities and the role of fire in successional development	3.3; 3.4
Forest health	1. Assess potential for pest incidence	• Conduct aerial and ground surveys	1.3.4; 1.3.5; 3.5
	2. Refine and reassess hazard ratings	• Collect age class, diameter, and stand descriptive data to improve the accuracy of future hazard assessments • Reassess changing hazard profiles with time and following natural or man-made disturbances	1.3.4; 1.3.5
	3. Monitor outbreaks	• Conduct ground surveys and probes to assess population expansion • Re-evaluate risks to Park values as well as adjacent areas	3.5; 4.0; 5.4
	4. Evaluate the threat to Park values	• Based on the results of objectives 1-3, determine if projected losses are acceptable in terms of stated values for the zone, the Park and adjacent areas	3.5; 4.0; 5.4
	5. Contain outbreaks which represent a significant threat to Park values	• Conduct single tree treatments, with or without pheromone baiting • Initiate stand replacement wild fire	5.4.3; 5.4.5

Table 17 continued

Management Issues	Objectives	Action	Section Reference (Part 1)
Forest health continued	6. Decrease the probability of future outbreaks occurring in high hazard areas	• Use thinning/silvicultural treatments to reduce stand susceptibility in high risk areas • Use single tree treatments to remove spot infestations in high hazard areas • Initiate stand replacement wildfire	5.4.3; 5.4.6
	7. Monitor and minimize negative impacts of wildfires on forest health	• Conduct ground surveys and monitoring of insect populations in burnt areas	5.4.2
Wildlife	1. Improve inventory	• Conduct inventories of wildlife utilization in the zone	3.6; 5.2
	2. Improve understanding of habitat utilization	• Study habitat use of important wildlife populations	3.6; 5.2

3.4 The Travel Corridor - EMZ4

The Travel Corridor is a narrow, 200-metre strip on either side of Highway 16 and railway right-of-ways (ROWs) through the centre of the Park. Due to the scale of the map, the width of the Travel Corridor has been exaggerated in Figure 14. In areas were the highway and railway are separate, this zone will be wider than 400 m. A management approach of permitting natural disturbances to occur unchecked is heavily constrained in this zone by concerns for visitor safety, the potential for damage to park and ROW infrastructures, interactions of wildlife and ROWs, and by the even-aged nature of the forests in the zone. Forests in the zone are primarily young forest stands dominated by lodgepole pine that have resulted from railway fires of the early 1900s. Early seral stages of Park ecosystems are also maintained along ROWs by vegetation management procedures. The management approach in the Travel Corridor is to immediately suppress all fires, monitor and action all potential pest outbreaks, and actively control the wildlife movements and habitat composition. Changing vegetation management along ROWs is also a major management objective to reduce wildlife collisions in the Travel Corridor, and to deal with the influx of non-native vegetation.

3.4.1 Biodiversity Conservation

Biodiversity conservation is a major management concern in the Travel Corridor, because of high visitor use, high levels of vegetation management along ROWs, dense populations of non-native plants due to the construction of provincial park and ROW infrastructures and key wildlife habitat. All of these factors have the potential to impact biodiversity, both indirectly, as a result of high traffic and invasion of ROWs by non-native vegetation, and directly, because of Park and infrastructure developments. As a result, an assessment of rare and endangered plant and animal species, and rare or important ecosystems should be conducted immediately to determine the scale of issues. If necessary, appropriate protection procedures should be employed to conserve the ecosystems identified. Such an inventory will also make it possible to conduct the active management strategies proposed for the zone without imperilling important biodiversity areas.

3.4.2 Fire

A full suppression policy will be employed in the Travel Corridor—all fires will be actioned immediately. The primary reason for this designation is to ensure the safety and security of park visitors, and Park and ROW infrastructures. In that the present forest cover is predominately an even-aged stand of lodgepole pine, active management strategies to deal with pest outbreaks or to reduce the potential for future pest outbreaks may be required, and these must be compatible with fire hazard factors such as fuel loading and stand structural characteristics. These are discussed in Section 3.4.3.

3.4.2.1 Fire Hazard and Management in Campgrounds and Park Headquarters

A number of provincial park facilities and campgrounds were visited as part of the field reconnaissance work. In particular, the staff and storage area near Park Headquarters, which is bordered on all sides by high hazard lodgepole pine forest, and includes buildings, and fuel sheds directly adjacent to the forest edge. This situation is undesirable from a fire protection point of view because fire suppression in this area would be difficult, given the close proximity of fuel storage facilities and other flammable materials to the forest stands. A buffer between the forest and these facilities and structures should be created, and fuels and other flammable materials should be stored in fire proof sheds.

Campgrounds in the vicinity of the Park headquarters are developed in high hazard, even-aged lodgepole pine stands in advance stages of secondary succession. In the absence of fire these stands will begin to self-regenerate on very dry sites in gaps (small scale mortality events) or, on less water deficient sites, show recruitment of advance regeneration of several species, such as subalpine fir, Engelmann spruce, Douglas-fir and lodgepole pine, in gaps, and along stand edges. To maintain integrity and reduce fire hazard of forest stands in this highly used area, coarse woody debris should be controlled to lower fire hazard. Also, the natural regeneration of subcanopy species should be encouraged by: (a) using naturally created, windfall gaps or expanding existing gaps, and creating small openings (0.01 to 0.03 ha in size) which would be large enough to satisfy light requirement of the species occupying the site; (b) exposing mineral soil; and (c) seeding. It is recommended that a small trial be designed and implemented, to determine the most effective methods.

Stands in the Lucerne Campground area have high density and pose a significant fire hazard, particularly since campfires are permitted within most of the sites. Some form of thinning treatment should be considered for these stands so that stand densities can be controlled and the crown continuity reduced or fires should be limited in areas of high hazard conditions.

In all of the campground areas visited within the Park, many overhanging trees adjacent to campfire sites were considered a hazard. This was due mainly to the low crowns and the close proximity of the fire rings to adjacent forest stands. Serious consideration should be given to pruning trees around these sites and removing trees that are close (within 5 m) to the campfire area. If these activities are carefully planned and conducted during the early or late part of the year, the impacts of treatments on the visual quality and aesthetics of these campground areas will be minimized.

3.4.3 Forest Health

The majority of high hazard stands for the MPB lie within or adjacent to the Travel Corridor (see Appendix 6). Management objectives and actions in this zone are identical to those for the Suppression Zone, however the extremely high use and visibility of this area demands that it receive the greatest attention. As discussed above, fire suppression practices are in direct conflict with management for the MPB in these areas. Therefore, early detection and monitoring of infestations, continued hazard assessments and concurrent treatments for long-term reductions of high susceptibility are especially critical. Management decisions for existing infestations should be based upon stand hazard, risk of spread to other areas of the Park or adjacent areas, and an evaluation of the threat to other Park management objectives. Pheromone baiting followed by spot treatments using; burning, debarking or lethal tree (MSMA) tactics may be required to contain and concentrate high-risk beetle populations. Employing these tactics requires careful consideration since several years of repeated infestation and treatment could result in large, undesirable openings in the forest. Allowing most of these infestations to progress unimpeded may be the best solution as they will thin the stands while they are still in a moderately low susceptibility age class. Allowing these stands to be naturally thinned by MPB infestations now should leave them less susceptible to major outbreaks in the future.

3.4.4 Wildlife

The most important management objective for wildlife in the Travel Corridor is to reduce roadkills on the highway and railway ROWs. Much more data is available for the highway ROW, and, as a result more detailed management approaches are described for the highway ROW. Given the low availability of reliable data on ungulate mortalities along the railway ROW, only general recommendations are made here. The recommended approach for dealing with ungulate mortality along the highway ROW has two components–actions regarding vegetation management within the ROW, and actions to be taken in forested ecosystems adjacent to the ROW.

3.4.4.1 Management Objectives - Highway ROW

Reducing ungulate mortality on the highway ROW has three components and includes:

- reducing the attractiveness of ROW vegetation as a forage source by shifting the species composition of vegetation on the ROW;
- providing Sware-flex reflectors and/or one-way exclusion fencing in areas of highest and persistent ungulate mortality; and
- increasing the attractiveness of the gas pipeline ROW so that ungulates are attracted away from the transportation ROWs.

The primary goal of vegetation management along the highway ROW is to convert the vegetation from palatable species to unpalatable species to discourage ungulate feeding. In Mount Robson Provincial Park, palatable plants such as grasses, clovers, saskatoon, aspen, and red-osier dogwood may be removed to facilitate the establishment and growth of less-palatable species such as kinnickinnick, soapberry, and juniper. Following removal, the establishment of unpalatable species should be encouraged. Planting or seeding may be required. A vegetation ecologist should be consulted to determine the method of removal. The ecologist should also provide a list of woody species which might be used on vegetated ROWs.

The three potential methods of discouraging ungulate use of the highway ROW are chemical repellents, Sware-flex reflectors, and exclusion fencing.

Chemical repellents are expensive, costing from $1500-$4400 per application for 0.5 km of ROW. Effects are short-lived, and applications are needed each month to maintain effectiveness. They are generally impractical for large areas, and could only be used in the Park in circumstances where short term control is needed.

Sware-flex reflectors are placed along the highway so that headlights of passing cars shine on them creating a temporary visual "fence" along the side of the highway. This effect is designed to stop wildlife on the side of the highway from moving onto the highway while vehicles are moving past. Advantages of these reflectors are that they are much less expensive to install than exclusion fencing. Disadvantages are that animals have to be behind the reflectors in order to see them, and they are easily vandalized. Also, once the reflectors become dirty they are no longer effective, so that a rigorous maintenance schedule is needed to keep them clean (Ministry of Transportation and Highways, Environmental Services, Victoria).

There are several Sware-flex reflector studies ongoing in British Columbia at this time. Studies from other parts of Canada and the United States report mixed results. At present, use of Sware-flex reflectors cannot be recommended with confidence. Park managers should keep up to date on results of current research with regard to these reflectors. If they are found to be effective, they should be installed in the Park along non-fenced problem sections of Highway 16.

Fencing is the most effective way to keep ungulates off transportation corridors. The cost of fencing can be justified by conducting a cost-benefit analysis. Cost-benefit analysis is complex and beyond the scope of this report. A brief description of steps involved in completing such an analysis is given here.

Cost-benefit analysis compare the amount of money saved by reducing wildlife-vehicle accidents over the life of the fencing against the costs of installing and maintaining the fencing. Data on the costs of wildlife-vehicle collisions must be as area-specific as possible. Accurate estimates of benefits of fencing may be difficult to obtain and may have to be calculated using data from several sources. Accidents of different severity, i.e., vehicle damage only versus human injures or deaths, will have different values for cost-benefit analysis. Costs of each type of accident have been estimated by Ministry of Transportation and Highways at approximately $1000 for vehicle damage (this may vary regionally), $29 500 for human injury, and $1 222 000 for death. An estimate of the number of each type of accident should be calculated for each highway segment. Potential numbers of human fatalities and injuries resulting from wildlife–vehicle collisions can be approximated based on results from other studies. The benefits based on accidents prevented are totalled over the life of the fencing and compared to the cost of fencing.

Based on these considerations, one-sided fencing is recommended in the following high roadkill areas along the Travel Corridor, and should be considered after a cost/benefit analysis is done in the following areas:

- On the south side of Highway 16 between Kilometre 10 and 17. The aim of this fencing is to minimize the frequency of highway crossings in the moose winter range area. This recommendation is supported by the concentration of moose roadkills and moose sign found during the field visit (see Part 1, Section 5.2.1.1). As this is a high public use area in the Park, the location of the fence must be determined so that is does not interfere with tourist uses.
- Between Kilometre 45 and 59, Highway 16 runs along the edge of wetland and mixed forest habitats. These habitats are heavily used by moose year-round, and deer and elk in spring, summer and fall as evidenced by roadkills and findings from the field work (see Part 1, Section 3.6). One-sided ungulate exclusion fencing should be placed along the south side of the highway. Again, the aim of this fence segment is to reduce the frequency of crossing of deer, moose and elk using habitats adjacent to the highway.

The third component of the program to reduce ungulate mortality is to increase the attractiveness of the pipeline ROW. Providing nutritive vegetation along the pipeline may aid in drawing ungulates off the highway and railway ROWs. Clover, blue grasses and other palatable grass species should be seeded along the pipeline route. Shrubs such as red-osier dogwood, willows, trembling aspen, blueberries, roses, currants, Douglas maple, high bush cranberry, mountain ash, and saskatoon should be encouraged to grow along the edge of the pipeline and in the understory of forests adjacent to the pipeline ROW. Long term management of the pipeline should concentrate on making it as attractive to ungulates as possible. Hand clearing may be the best method to clear unwanted trees from the pipeline ROW.

3.4.4.2 Management Objectives - Natural Ecosystems Adjacent to the Highway ROW

Using the 1:50 000 ecosystem map of the Park (Lea and Maxwell 1993) to identify Biophysical Habitat Units (BHUs), management prescriptions have been provided for each BHU along Highway 16 in the Park. For each segment of highway Appendix 9 lists the wildlife capability for species using the polygons, the areas of each of the polygons in the segment, the distance of the polygon from the highway ROW, and management recommendations specific to the polygon. The general objective of the management recommendations is to make those BHUs that provide good foraging habitat less attractive if they occur adjacent to the highway ROW. BHUs to be treated can be prioritized so that areas of highest mortality are dealt with first.

3.4.4.3 Ungulate Mortality Along the Railway ROW

Data on the number of animals killed along the railway in the Park is lacking. Data collected by officials in Jasper National Park is also incomplete, but suggests that significant animal mortality may be occurring along the railway. BC Environment officials have expressed concern that the numbers of animals killed by trains is not being documented accurately. Most of the mortalities are thought to occur during winter months when the plowed rail lines offer ungulates (moose in particular) easy travel routes. Once on the cleared line, animals have no way to safely exit when approached by a train.

Documentation of animal mortalities along the railway ROW in the Park should begin. Special attention should be given to winter months, as moose winter range lies along the Travel Corridor. The railway ROW is subjected to herbicide treatments and is not thought to be used by ungulates for feeding. If significant numbers of animals are found to be killed, then methods of restricting access to the railway lines, changes in vegetation management, or methods of allowing animals off lines during winter need to be investigated.

Table 18 is a synopsis of management objectives, actions and relative priorities for the Travel Corridor Zone.

Table 18. Synopsis of management objectives, actions, and relative priorities in the Travel Corridor (EMZ4)

Management Issues	Objectives	Action	Section Reference (Part 1)
Biodiversity conservation	1. Determine the degree to which ROWs and natural ecosystems have been invaded by non-native vegetation, and develop a procedure for dealing with these issues	• Conduct an inventory to determine which non-native species are present and where they occur, especially where non-native plants are actively invading natural ecosystems • Identify noxious or restricted weed species • Prioritize species and/or invasion areas for treatment • Establish best eradication methods • Coordinate the development of eradication methods and develop cost-sharing approaches with ROW agencies	5.1
	2. Reduce the potential for future invasion of non-native plant species	• Develop guidelines for future development using native vegetation to replant disturbed areas	5.1

Table 18 continued

Management Issues	Objectives	Action	Section Reference (Part 1)
Biodiversity conservation continued		• Conduct public education to increase awareness of non-native plant issues	
	3. Determine the extent of rare or endangered plant and animal species or special ecosystems	• Conduct an inventory of rare or endangered species and habitats within the zone (conducted in 1999) • Develop procedures for conserving identified species as required	5.1
Fire	1. Improve monitoring of fire weather	• Establish and maintain a network of fire weather stations representing the diversity of climate within the zone (installed in 1997) • Establish a database with daily fire weather codes and indices relevant fire history information	5.3.2
	2. Obtain the ability to understand and model fire behaviour for the fuel types present in the Park	• In cooperation with the BCFS and CFS initiate staff training in the area of fire behaviour so that appropriate staff are prepared to make decisions related to actioning or leaving fires, given current and future predicted weather conditions	3.4; 5.3
	3. Develop a better understanding of those ecosystems which require fire processes for maintenance within this zone	• Conduct more research on specific vegetation communities and the role of fire in successional development	3.3; 3.4
Forest health	1. Assess potential for pest incidence	• Aerial and ground surveys (conducted in 1999)	1.3.4; 1.3.5; 3.5
	2. Refine and reassess hazard ratings	• Collect age class, diameter, and stand descriptive data to improve the accuracy of future hazard assessments • Reassess changing hazard profiles with time and following natural or man-made disturbances	1.3.4; 1.3.5

Table 18 continued

Management Issues	Objectives	Action	Section Reference (Part 1)
Forest health continued	3. Monitor outbreaks	• Conduct ground surveys and probes to assess population expansion (conducted in 1999) • Re-evaluate risks to other areas of the Park as well as adjacent areas	3.5; 4.0; 5.4
	4. Evaluate the threat to Park values	• Based on the results of objectives 1-3, determine if projected losses are acceptable in terms of stated objectives for the zone, Park values and adjacent areas	3.5; 5.4; 4.0
	5. Monitor and assess outbreaks which represent a significant threat to Park values	• single tree treatments or fall and burn, with or without pheromone baiting	5.4.3; 5.44; 5.4.5
	6. Decrease the probability of future outbreaks occurring in high hazard areas	• Use thinning / silvicultural treatments to reduce stand susceptibility • Use single tree treatments to remove spot infestations in high hazard areas	5.4.3 / 5.4.6

4.0 Management Objectives and Actions Across Ecosystem Management Zones

A number of management issues are not specific to a particular zone but rather refer to the Park as a whole. The development of fire weather stations and the need for public education are examples of these types of issues, and they are described in this section.

4.1 Developing a Fire Weather Station Network

A fire weather station network should be established within the Park. This network should consist of a minimum of three weather stations which are located as follows:

- near Park Headquarters (installed in 1997);
- in the Yellowhead Lake area; and
- in the upper reaches of the Fraser River near to Geikie Creek (installed in 1997).

Given the range of mesoscale climatic variation in the Park, a minimum of three stations will be required to reliably meet the management objectives described in this plan. The station in the Fraser River drainage would require telemetry to monitor daily fire weather. This station is important to assess fire conditions within the Prescription and Natural zones.

4.2 Public Education

The setting of Mount Robson Provincial Park provides an excellent opportunity to educate the public about basic ecological principles affecting the Park landscape. For example, fire and fire management represent an important component of the conservation mandate of BC Parks. A brochure, Prescribed Fire in Provincial Parks, was produced in 1998. BC Parks should better integrate discussions on the role and importance of fire in ecosystem functioning and management into its interpretative programs. This can include, but is not limited to, constructing signs in old burn sites, identification of stand level fire effects, and slide shows and interpretative programs within the Park. This is not only beneficial in increasing the public awareness on the role of fire, but would also help to aid and promote an understanding of why fire management practices are required within the Park.

A number of opportunities exist which could be used in the current interpretative program to promote the ecological role of fire within the Park. These include:

- Fire effects along the Berg Lake trail in the ICH - different aged cohorts established during different fire events which demonstrates the concepts of fire frequency and fire effects.
- The uniform age class structure of the Travel Corridor can be used to demonstrate the large scale effects of fire within the Park, and the effects of human development on the forest landscape.

- The life history of lodgepole pine could be used to demonstrate the role of fire and forest succession. Lodgepole pine within the Park requires fire to regenerate and this would be an excellent example of biological process and the influence of fire.
- There are many examples of how fire, both positively and negatively, influences wildlife habitat within the Park. These examples should be included as part of wildlife interpretative programs.
- More emphasis should be given to the issues of fire prevention, detection, and hazard abatement in public programs. Campfire safety and smoke management should be included in these discussions.

5.0 Summary and Implementation

A summary of management issues and actions discussed in the Ecosystem Management Plan for the Park is presented in Tables 19 to 22. More detailed summaries for each EMZ have been presented in the preceding tables and discussed in the relevant sections. The summary is intended as an overview of management actions required to meet the objectives of the Park Master Plan (1992).

5.1 Interagency Cooperation

Also included in Tables 19 to 22 are suggestions for the agencies that have the type of expertise required to carry out the management actions. In most cases staff of BC Parks will be required to work with other government agencies, private consultants, universities, and ROW agencies to maximize expertise and minimize costs to apply the management actions.

Actions listed as to be done by BC Parks alone in the tables are those that can be carried out by BC Parks staff or summer students at a relatively low cost, and with the expertise in BC Parks. These can be implemented as soon as possible. Many of the other tasks listed will require expertise from other areas.

To implement more technically demanding aspects of the plan, BC Parks should develop relationships with the appropriate agencies, as suggested in the tables. For fire issues the Canadian Forest Service (CFS) has a very capable working group in Victoria that is well informed about all issues suggested in this plan, and have assisted BC Parks in other areas of the Province. The Ministry of Forests (MOF) also has competent staff in Victoria, as well as informed district and regional protection staff who are well aware of the forest health issues dealt with here. Similarly, the CFS and MOF have the expertise to address many of the forest health issues in the Park, and their assistance should be solicited as well. Another source of expertise is professional staff responsible for dealing with identical management issues in the adjacent national parks, and the cooperation and communication already ongoing should be expanded.

For matters of biodiversity conservation, staff of the Royal BC Museum have already completed a partial plant list for the Park, and should be encouraged and supported to continue this work. Their expertise in plant and animal taxonomy is difficult to find in other agencies.

For some of the issues required to implement the plan, another source of expertise will be university researchers. In particular, partnerships with appropriate scientists at the University of Northern British Columbia should be developed for matters of mutual interest. Similar relationships could also be developed with resource scientists at the University of Victoria and the University of British Columbia. The Foothills Model Forest has also expressed interest in conducting research at the site of the Moose River burn.

For management issues and actions along ROWs the appropriate ROW agencies should be approached for cooperation on funding applications, for providing funds directly, and for providing expertise that they may have. In particular, the cooperation of the Ministry of Transportation and Highways, and Canadian National Railways should be sought for work on their respective ROWs.

By developing ongoing relationships with all of these agencies, the feasibility of implementing the management plan put forward here will be increased, and the requirement for hiring private consultants can be kept to a minimum.

5.2 Implementing the Plan

Given the cooperation of relevant agencies as discussed above, all aspects of the plan can be implemented while keeping costs at a minimum. Some of the management actions refer to the development of park guidelines and can be implemented as soon as BC Parks have the time to address the issues. Developing fire evacuation plans, programs of public education, and hazard reduction planning around park structures are examples of this type of management action.

Other actions will involve considerable planning, and need to be done in a logical series of steps. For example, an inventory of rare and endangered species needs to be completed before any active management strategies can be employed. This inventory should be planned as soon as possible, and EMZs should be prioritized, starting with the Travel Corridor and the Prescription Zone. An important issue with high priority is prescribed burning of the even-aged lodgepole pine stand that runs along the Travel Corridor through the Park. As discussed, considerable planning will have to be done to fine tune the pest hazard ratings, ensure that the area burned will also benefit wildlife habitat, ensure that the fire is in a fuel type and topographic area so that the fire can be contained, ensure that any rare of endangered plant or animal species will be not affected, and ensure that visitor safety is not compromised. This will require considerable time and planning on the part of BC Parks. A similar intensity of planning will be required to complete other management actions, such as reducing ungulate mortalities along the highway ROW, or dealing with non-native plant issues.

The suggested approach to implement the actions outlined in the plan is to develop a large flow chart to outline the tasks to be conducted, target dates for completion, cooperating agencies to be involved, and interaction between the different areas of expertise. Such an action plan will provide a coordinated framework for implementing the management issues and actions outlined in the plan.

Table 19. Summary of biodiversity conservation management issues and recommended agencies to carry out the work

Management Issue	Management Actions	Recommended Agency[1]
• Identification of populations of rare or endangered species	• In conjunction with the BC Conservation Data Centre, develop list of possible rare or endangered species that may occur in the Park (completed in 2000)	BCP
	• Prioritize areas for inventory work; active management areas (Prescription Zone, Travel Corridor) or high use areas (campsites, trails, day use areas) should receive the highest priority	BCP
	• Conduct inventories of rare or endangered species within the Park (completed in 2000)	CON, UNIV
• Identification of critical, sensitive, or otherwise special ecosystems	• Summarize areas of BHUs within EMZs using ecosystem mapping for the Park; with wildlife and biodiversity conservation specialists, identify ecosystems that are sensitive to disturbance, that create important and/or critical wildlife habitat, or that may contain rare or endangered species	BCP, CON
	• Utilize this information for decision-making for active management within the Park	BCP
• Assessment and control of non-native plants	• Determine present levels of non-native vegetation along the Park ROWs and in natural communities adjacent to ROWs	CON, UNIV
	• Develop best methods for eradicating undesirable species and establishing native vegetation	CON, UNIV
	• Prioritize areas and carry out eradication treatments	CON, UNIV

Table 20. Summary of fire management issues, and recommended agencies to carry out the work

Management Issue	Management Actions	Recommended Agency[1]
• Fuel hazard reduction planning	• Reduce potential ignitions from Park buildings, campsites, trails and day use areas	BCP
	• Reduce forest stand fuels and manipulate structure and species composition of stands surrounding Park buildings, campsites, trails, and day use areas	BCP, CON
• Visitor safety	• Develop evacuation plans for major use areas	BCP

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[1] BCP=BC Parks, MOF=BC Ministry of Forests, CFS=Canadian Forest Service, UNIV=university researchers and students, CON=Consultants, JNP=Jasper National Park, CN=Canadian National, MOTH= Ministry of Transportation and Highways, TMP=Trans Mountain Pipeline, BCT=BC Tel

Table 20 continued

Management Issue	Management Actions	Recommended Agency[1]
• Prescribed fire/prescription wildfires	• Establish fire weather stations (completed in 1997)	MOF, CON
	• With fire, forest health, biodiversity conservation, and wildlife specialists, identify and prioritize potential areas for prescribed burning	BCP, CON
	• Conduct research into fire behaviour and develop models for fuel types in candidate areas for prescription burning and for the Prescription Zone	MOF, CFS, UNIV
	• Develop conservative and reliable prescriptions for prescribed fire and prescription wildfire in areas to be managed	MOF, CFS, UNIV
• Public education	• Develop public education programs to increase awareness of fire hazard and general fire management issues	BCP
• Adjacent values	• In conjunction with neighbours, conduct inventories of significant ecological values adjacent to Park boundaries; reassess risks for different ecosystem management zones	MOF, JNP
• Fire ecosystem research	• Conduct research to more precisely determine historical fire cycles (paleoecology, dendrochronology), role of early man, maintenance of fire systems	MOF, CFS, UNIV, CON

Table 21. Summary of forest health management issues and recommended agencies to carry out the work

Management Issue	Management Actions	Recommended Agency[1]
• Ongoing surveillance and actioning	• Assess all incidences of pest occurrences	BCP, CFS, MOF, CON
	• Assess risks and management actions for each outbreak	BCP
• Refine and reassess hazard ratings	• Prioritize stands for field assessments; use existing hazard maps to identify polygons that represent a high present of future risk	CON
	• In selected areas measure stand characteristics to refine hazard assessments; update management as required	CON
	• With fire, forest health, biodiversity conservation, and wildlife specialists, identify and prioritize potential areas for prescribed burning (underway 2001)	BCP, CON, MOF, CFS, JNP

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[1] BCP=BC Parks, MOF=BC Ministry of Forests, CFS=Canadian Forest Service, UNIV=university researchers and students, CON=Consultants, JNP=Jasper National Park, CN=Canadian National, MOTH= Ministry of Transportation and Highways, TMP=Trans Mountain Pipeline, BCT=BC Tel

Table 21 continued

Management Issue	Management Actions	Recommended Agency[1]
• Public education	• Increase public awareness of forest health issues	BCP

Table 22. Summary of wildlife management issues and recommended agencies to carry out the work

Management Issue	Management Actions	Recommended Agency[1]
• Increase inventories and habitat information for Park wildlife populations	• Determine if woodland caribou are using the Moose River-Resplendent Creek valley as winter habitat (assessment completed in 1998, see Appendix 8)	BCP, UNIV, CON
	• More precisely determine the habitat requirements of wintering caribou in particular, and other Park mammals such as ungulates and grizzly bears	BCP, UNIV, CON
• Restore summer and winter caribou habitat in the Prescription Zone	• Inventory and sample areas for potential habitat restoration	BCP, CON
	• In consultation with biodiversity conservation, fire and forest health specialists, select candidate areas for prescription burning (underway 2001)	BCP, CFS, MOF, CON
	• Following fire research and prescription development (Table 16) conduct prescription burns to meet enhanced habitat targets	BCP, CFS, MOF, CON
• Decrease incidences of ungulate mortalities along highway ROW	• Reduce ungulate use of forests adjacent to the highway ROW by applying BHU-specific management approaches	CON
	• Reduce ungulate use of highway ROW using a combination of three approaches:	
	• decrease the attractiveness of ROW vegetation by replacing valuable forage species	CON, MOTH
	• increase the attractiveness of the Trans Mountain ROW to attract animals away from the highway by planting important forage species	CON, TMP, BCT
	• conduct cost-benefit analysis, and if merited, establish one way fencing along the most problematic sections of the highway	BCP, MOTH, CON
• Decrease incidences of ungulate mortalities along railway ROW	• Analyze the accuracy of historical ungulate mortality	BCP, CN, UNIV, CON
	• Set up a system to document ongoing mortality	BCP, CN
	• Develop methods for allowing escape from the ROW during months with heavy snow accumulation	CN, BCP, CON

[1] BCP=BC Parks, MOF=BC Ministry of Forests, CFS=Canadian Forest Service, UNIV=university researchers and students, CON=Consultants, JNP=Jasper National Park, CN=Canadian National, MOTH= Ministry of Transportation and Highways, TMP=Trans Mountain Pipeline, BCT=BC Tel

Glossary

Alluvial: produced by running water; mainly referring to the products of erosion and deposition (i.e., sand and gravel)

Aspect: the apparent position of the sun relative to the slope

Attribute Data: non-graphic information associated with a point, line or area element

Attribute File: a computer file containing attribute data

BHUs: Biophysical Habitat Units

Biogeoclimatic Ecosystem Classification (BEC): a system of ecosystem classification used throughout British Columbia for developing ecologically-based forest management strategies

Blankets: surficial materials greater than 1 m in depth

Colluvium: sediments deposited at the foot of a slope through mass wasting processes such as slides, falls, and creep

Crown Class: describes the crown position of an individual tree relative to the other trees within the stand—Crown classes include dominant, codominant, intermediate and suppressed and are a basis for judging the vigour of the stand

Crown Closure: the distance between individual tree crowns in the canopy of a forest stand

Database: a collection of related information

Disclimax: a type of climax community where the natural climax vegetation is altered due to disturbances such as burning and avalanches

Ecological Gradient: a gradual change in ecological factors across the landscape, e.g., from the top to the bottom of a slope

Field: a column position within a database table used to store an attribute value

Fire Brands: any burning material such as leaves, wood, glowing charcoal and sparks, capable of starting a forest fire

Fire Cycle: the number of years required to burn over an area equal to the whole area of the forest

Fire Hazard Zones: in fuel management, the existence of a fuel complex that constitutes a threat to wildfire ignition, unacceptable fire behaviour and severity, or suppression difficulty

Fluvial: related to rivers or streams

Forest Cover Map: a map showing the present forest stands in a given area

Forest Ecosystem Polygon: a map unit equivalent in climate, soil moisture and soil nutrients, and vegetation composition and structure

Fuel Inventory: a list of fuels categorized by size classes and including both fine (<1 cm) and coarse (<1 cm) fuel materials

Fuel Loading: the dry weight of combustible materials per unit area, usually expressed as kg/m^2

Geographic Information Systems (GIS): an integrated set of hardware and software tools for the collection, maintenance, analysis and display of geographically referenced data

Glaciofluvial: course sands and gravels produced by meltwater streams flowing from glaciers, including meltwater erosion and deposits

Hydric: water removed from soil somewhat slowly resulting in periods of prolonged saturation and permanent seepage during the growing season

Ladder Fuels: fuels that provide vertical continuity between surface fuels and crown fuels in a forest stand, thus contributing to the ease of torching and crowning

Landform: a feature that expresses the form of the land surface

Mapping Unit: a set of areas drawn on a map to represent a well-defined feature or set of features

Mesic: water removed from soil somewhat slowly; soil may remain moist for a significant or short period of the year

Morainal: a landform composed of an accumulation of glacial drift, mainly till, built by glacial ice and having a variety of relief forms

NAD27 and NAD83: refers to the North American datum of 1927 and 1983 respectively. NAD27 refers to a set of parameters defining the earth's spheroid for mapping the North American continent as a result of an international conference in 1927. NAD83 refers to updated parameters adopted as the basis for mapping North America in 1983.

Pest: an organism that affects resources used by humans in a significantly negative manner

Physiographic: describes the physical aspects of the landscape such as slope degree and shape

Polygon: a geometric map entity representing an area with homogeneous or associated attributes

Site Unit: an area uniform in site quality (includes site association, site series and site type)

Site Series Map: a group of sites within a regional climate uniform in soil moisture and nutrients

Site Type: division of site series which are uniform in landform and/or soil characteristics

Snag: standing dead tree from which needles (leaves) and most of the branches have fallen

Stocking: describes the distribution and number of trees in a stand, and is usually expressed on a per unit area basis (e.g., stems/ha)

Subhydric: water removed slowly enough to keep soil wet for a significant part of the growing season and cause temporary seepage

Submesic: water removed readily from the soil, resulting in limited availability of water following precipitation

Successional Stage: one of several, structurally distinct, vegetation stages that occurs on a site following disturbance of the existing vegetation

Thematic Map: a map displaying selected kinds of information relating to specific themes, such as biodiversity, surficial geology, hydrology and wildlife

Topographic Influence: the influence exerted by a landform or physiographic feature on the vegetation located thereon

Terrain Resources Information Mapping (TRIM): refers to B.C. Crown Lands digital mapping of the province at a scale of 1:20 000 scale from new aerial photography using NAD83

Veneer: a mantle of unconsolidated materials too thin to mask the minor irregularities of the surface of the underlying materials—a veneer ranges in thickness from 1 cm to 1 metre

Wildlife capability: the potential of a specified area, in an optimal succession stage, to produce a given number of animals of a particular species

Wildlife Suitability: the ability of specified habitat, in its' current state, to produce a given number of animals of a particular species

Windthrow: a tree or group of trees that have been felled by heavy wind

Xeric: the relatively driest soil moisture regime within a given regional climate

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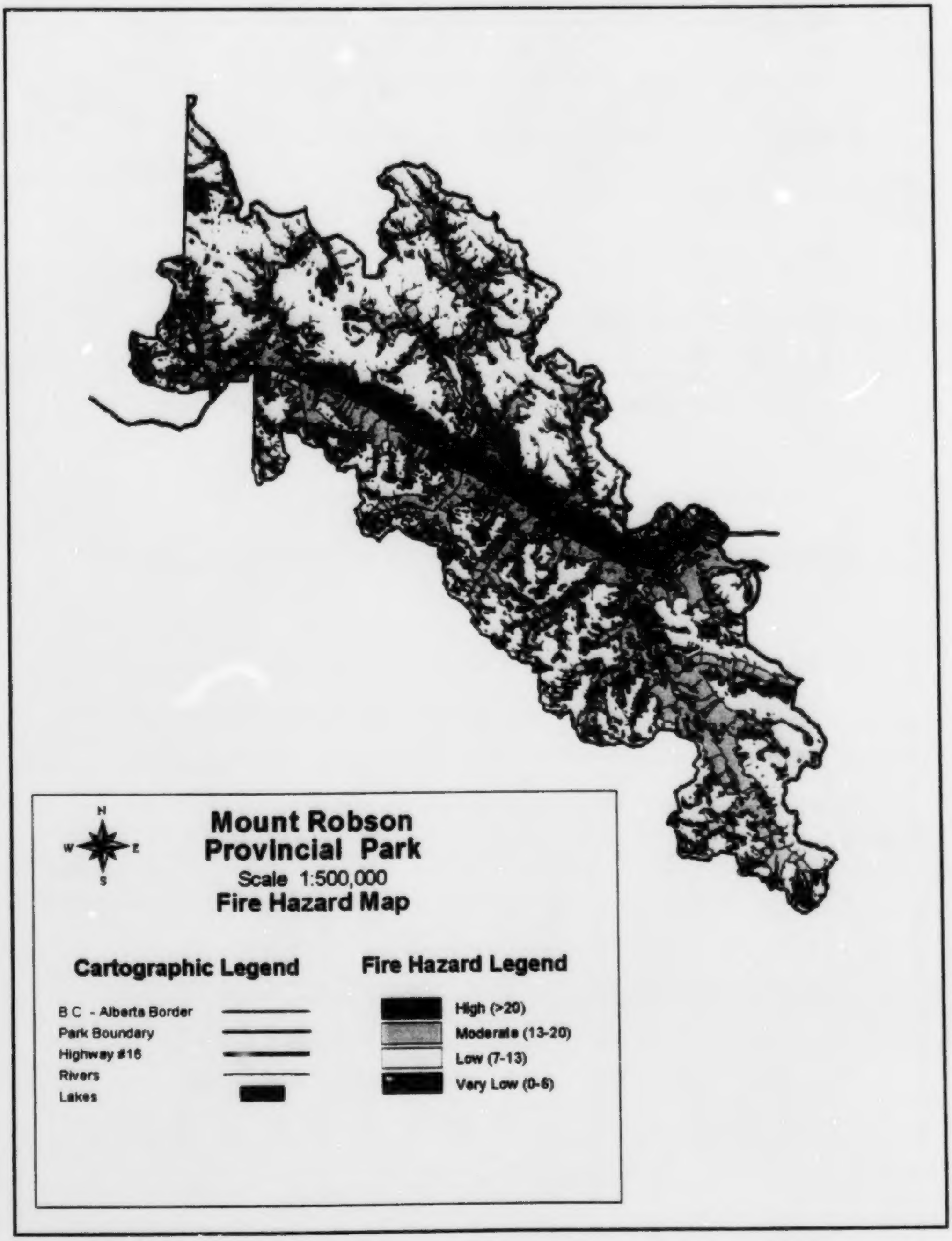
Appendix 1. Fire Hazard Map of Mount Robson Provincial Park


N
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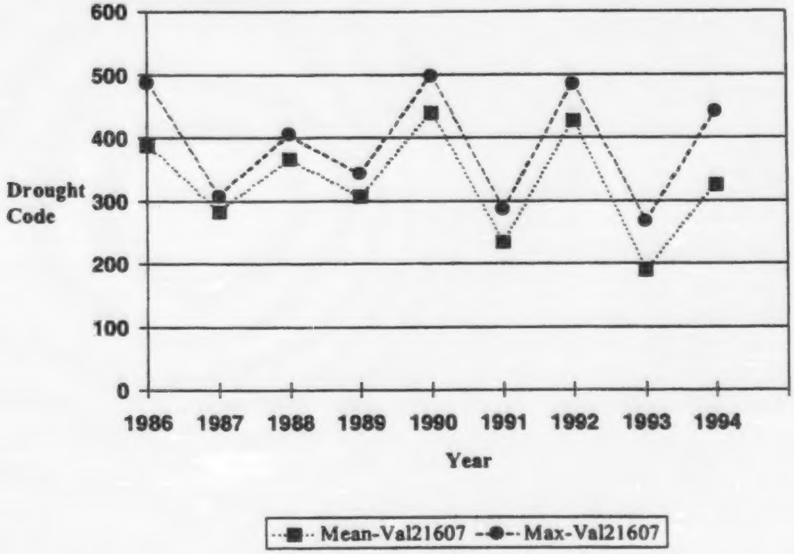
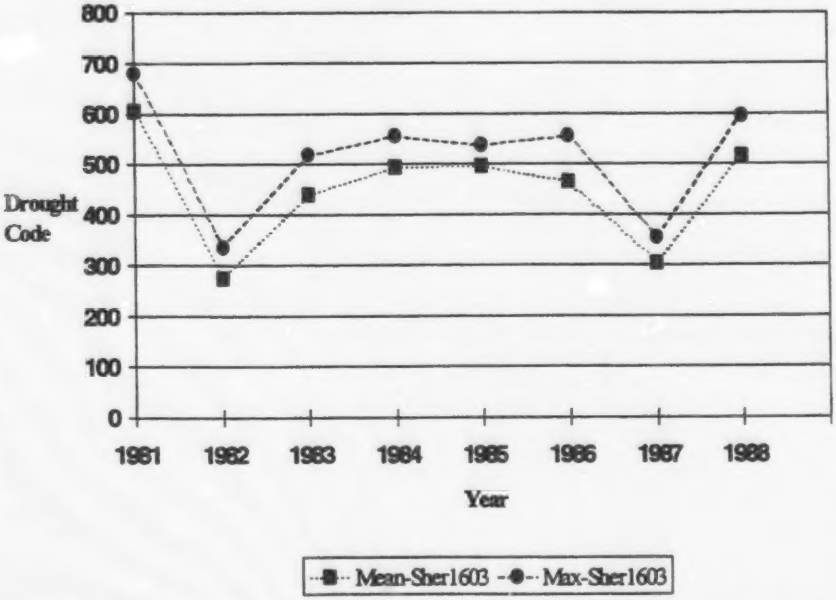
Mount Robson
Provincial Park
Scale 1:500,000
Fire Hazard Map
Cartographic Legend
B C - Alberta Border
Park Boundary
Highway #16
Rivers
Lakes
Fire Hazard Legend
High (>20)
Moderate (13-20)
Low (7-13)
Very Low (0-6)

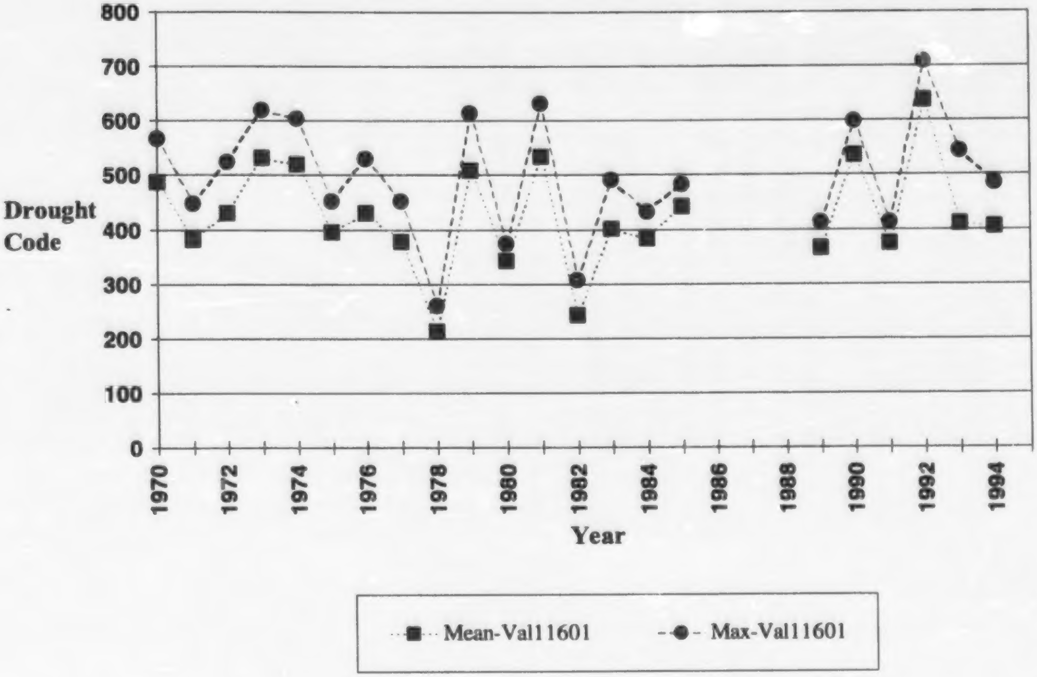
Appendix 2. Mount Robson Provincial Park Fire Weather Data Summary (data provided by B.A. Blackwell and Associates Ltd.)



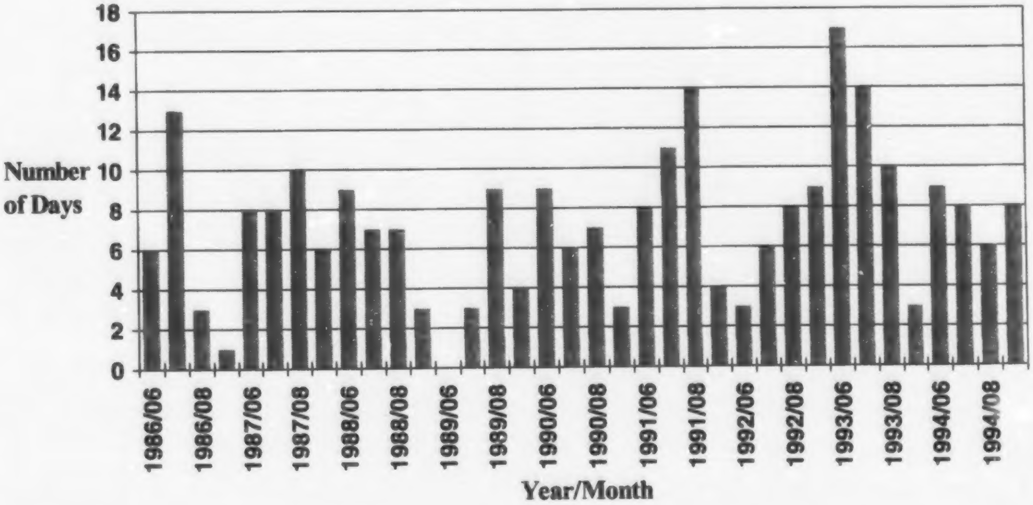
Mean and maximum August Drought Code for Station Val21607, 1986-1994



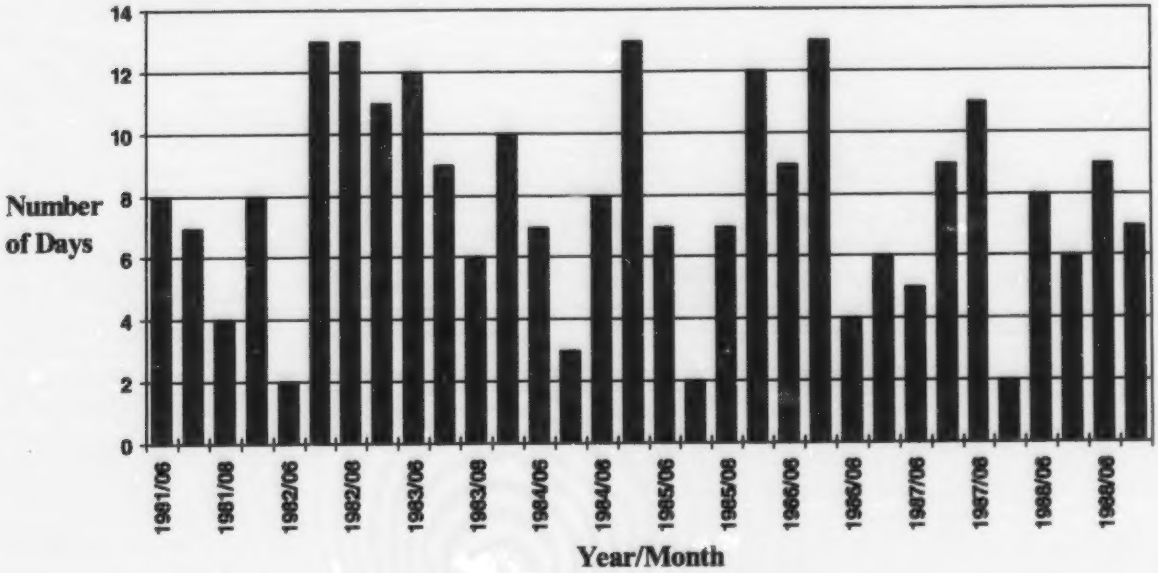
Mean and maximum August Drought Code for Station Sher1603, 1981-1988



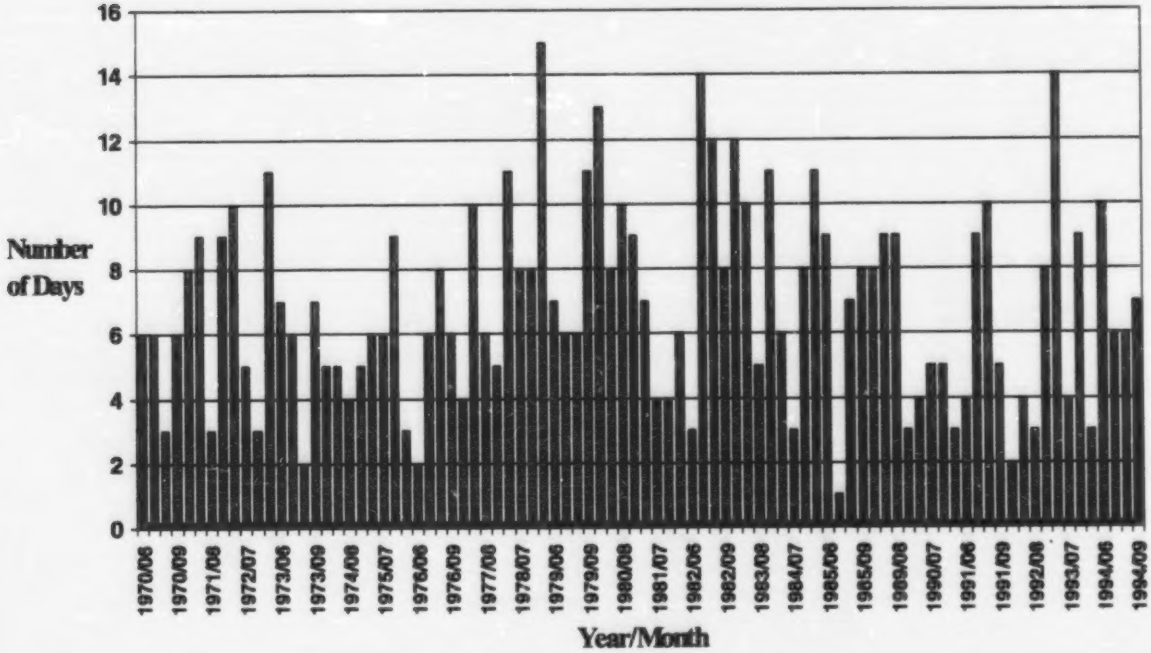
Mean and maximum August Drought Code for Station Val11601, 1970-1994



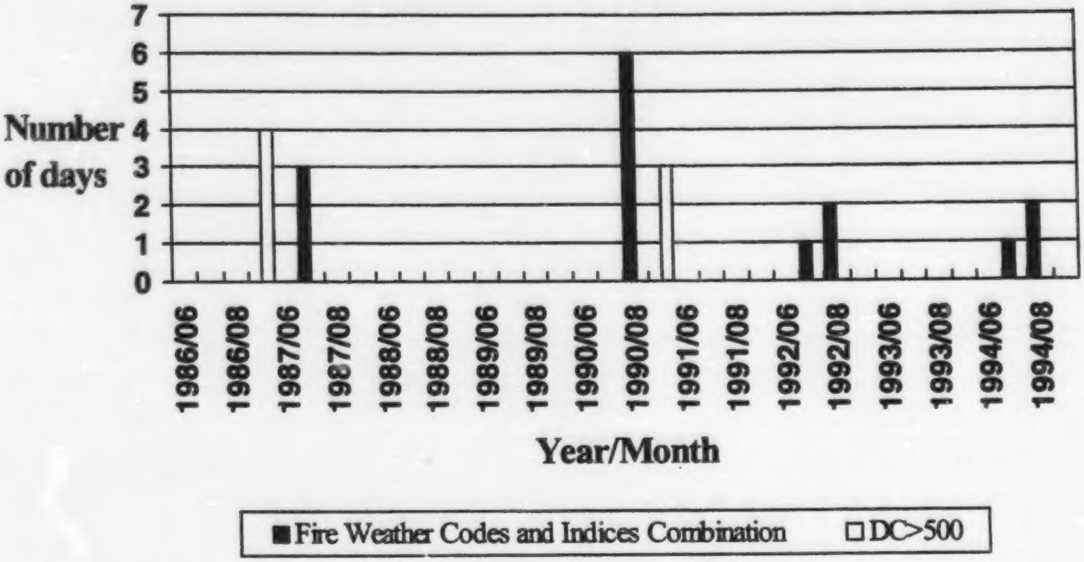
Number of days/month with rainfall >1.5mm for Station Val21607, 1986-1994



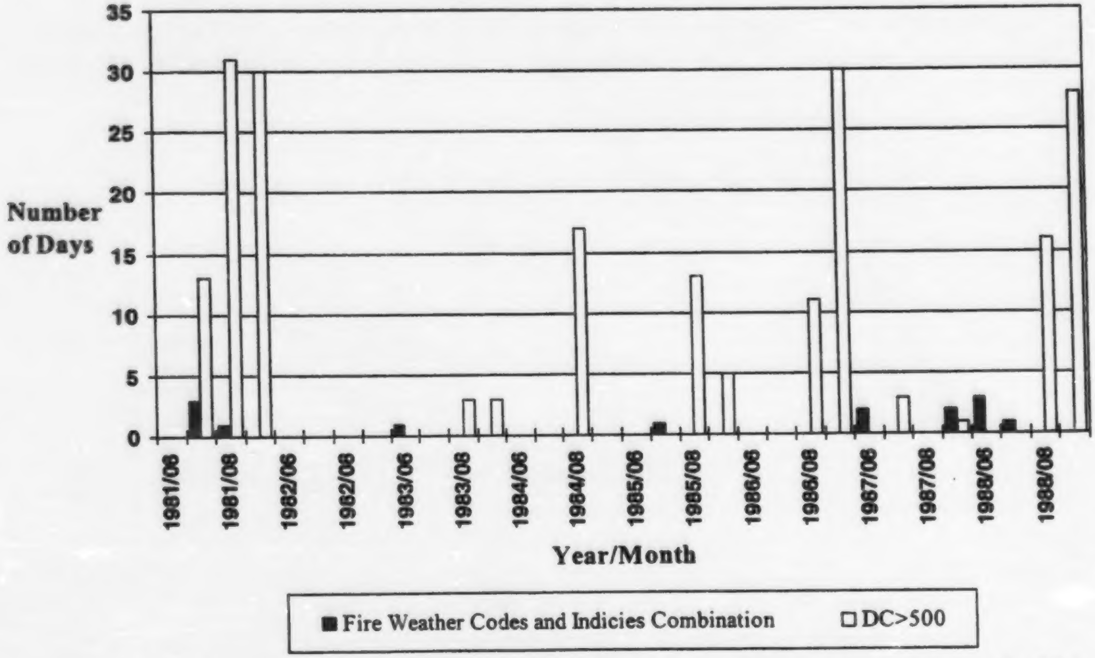
Number of days/month with rainfall >1.5 mm for Station Sher1603, 1981-1988



Number of days/month with rainfall >1.5 mm for Station Val11601, 1970-1994



Number of days/month for fire weather codes and indices for significant ignition and spread of fire (FFMC[1] ≥ 88; DMC ≥ 40; DC ≥ 250; ISI ≥ 8 or for D > 500 at Station Val21607, 1986-1994



Number of days/month for fire weather codes and indices for significant ignition and spread of fire (FFMC ≥ 88; DMC ≥ 40; DC ≥ 250; ISI ≥ 8 or for D > 500 at Station Sher1603, 1981-1988

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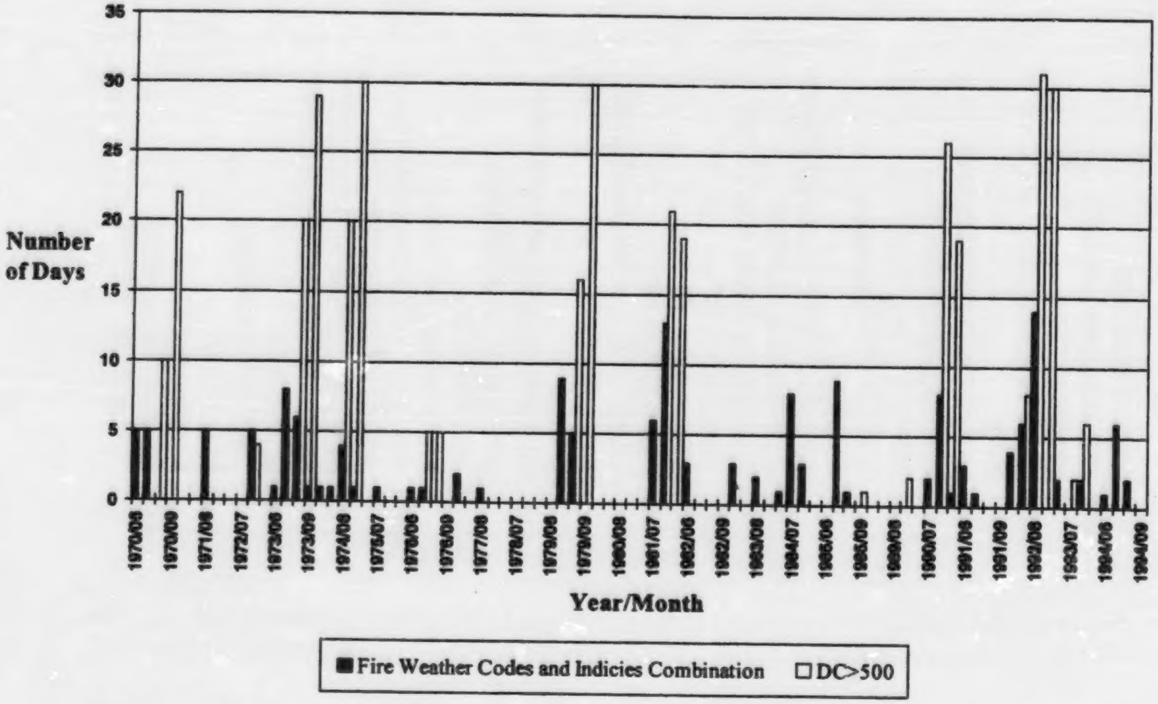
[1] FFMC = fine fuel moisture code; DMC = diff moisture code; DC = drought code; ISI = initial spread index

MOUNT ROBSON PROVINCIAL PARK



Number of days/month for fire weather codes and indices for significant ignition and spread of fire (FFMC[1] ≥ 88; DMC ≥ 40; DC ≥ 250; ISI ≥ 8 or for D > 500 at Station Val12607, 1970-1994

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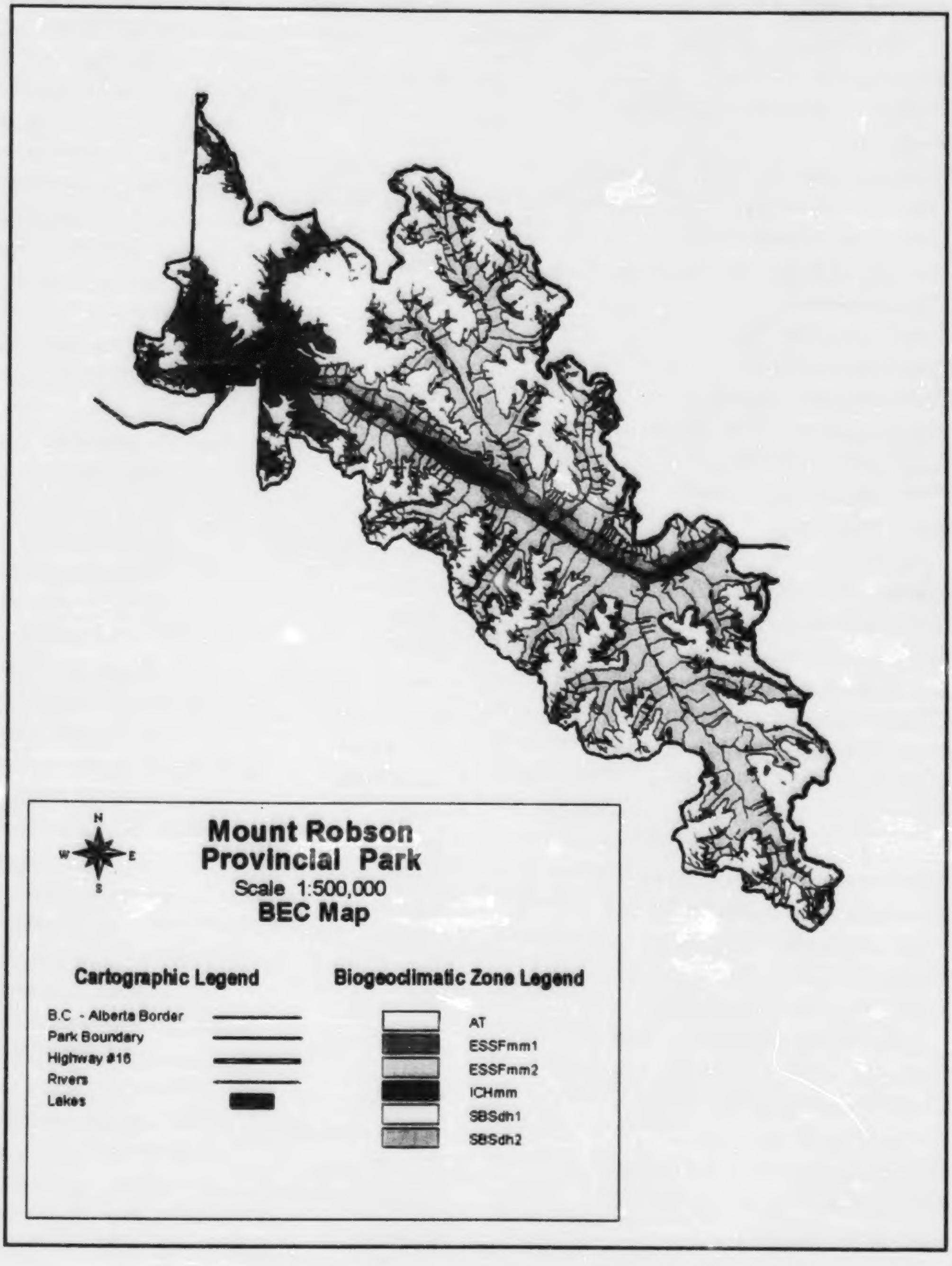
[1] FFMC = fine fuel moisture code; DMC = diff moisture code; DC = drought code; ISI = initial spread index

Appendix 3. Biogeoclimatic Zone Map of Mount Robson Provincial Park


N
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Mount Robson
Provincial Park
Scale 1:500,000
BEC Map
Cartographic Legend
B.C - Alberta Border
Park Boundary
Highway #16
Rivers
Lakes
Biogeoclimatic Zone Legend
AT
ESSFmm1
ESSFmm2
ICHmm
SBSdh1
SBSdh2

Appendix 4. Scientific and Common Names of the Plant Species Occurring in Mount Robson Provincial Park

Scientific Name	Common Name
Braya humilis (C.A. Meyer) Rob.	false rock cress
Bromus vulgaris (Hooker) Shear	common brome grass
Bryum spp.	moss
Calamagrostis rubescens Buckley	reddish reed grass
Calamagrostis canadensis (Mx.) Nutt	Canadian reed grass
Campanula rotundifolia L.	common harebell
Campylium stellatum (Hedw.) C. Jens	moss
Carex capillaris L.	sedge
Carex conianna Br.	sedge
Carex eburnea Boott.	sedge
Carex vaginata Tausch	sedge
Carex nigricans C.A. Meyer	sedge
Carex soirpoidea Ms.	sedge
Carex spectabilis Dewey	sedge
Carex saxatilis L.	sedge
Castilleja miniata Douglas	Indian paintbrush
Cetraria islandica (L.) Ach.	lichen
Cetraria nivalis (L.) Ach.	lichen
Cetraria canadensis Ras.	lichen
Chimaphila menziesii (Br.) Sprengel	little prince's pine
Chimaphila umbellata (L.) Barton	prince's pine
Cinna latifolia (Trev.) Gris.	woodreed
Circaea alpina L. Echanter's	night shade
Cladonia chlorophaea (Flk.) Sprengel	lichen
Cladonia cornuta (L.) Hoffm.	lichen
Cladonia ecmocyna (Ach) Nyl.	lichen
Cladonia furcata (Huds) Schrad.	lichen
Cladonia fimbriata (L.) Fr.	lichen
Cladonia spp.	lichen
Cladonia gracilis (L.) Willd.	lichen
Cladonia rangiferina (L.) Wigg.	lichen
Cladonia arbuscula (Wallr.) Rabenh.	lichen
Cladonia uncialis (L.) Wigg.	lichen
Clematis columbiana T. & G. Purple	virgin's bower
Clintonia uniflora (Schultes) Kunth.	Queen's cup
Corallorhiza trifida Chatelain	pale coral root
Cornus canadensis L.	bunchberry
Cornus stolonifera Mx.	red osier dogwood

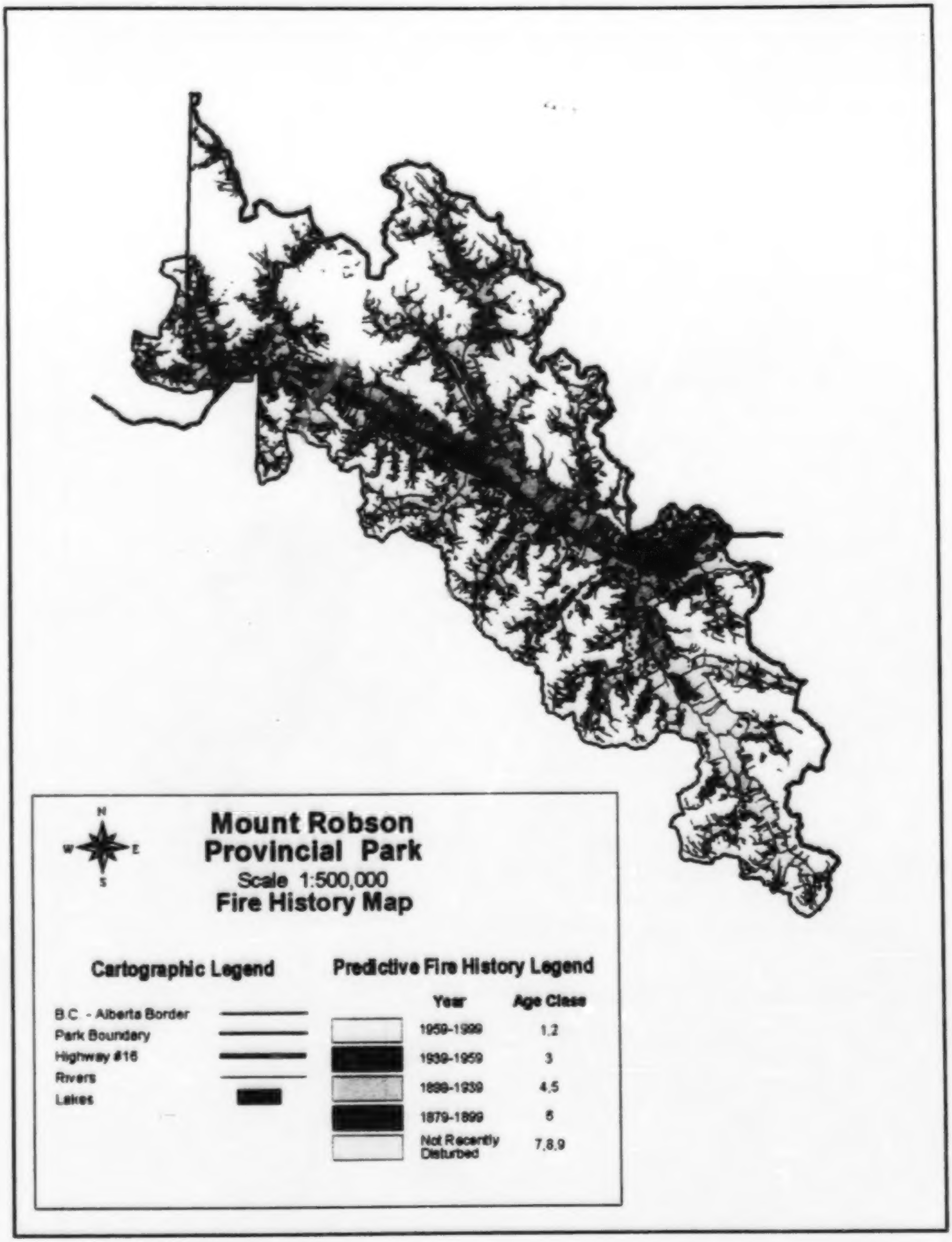
Scientific Name	Common Name
Corylus cornuta Marsh.	hazel
Cryptogramma crispa (L.) Br.	rock brake
Cypripedium calceolus (Sal.)	yellow lady slipper
Cystopteris montana (Lam.) Bernh	mountain bladder fern
Dactylina arctica (Hook.) Nyl.	lichen
Dantonia intermedia Vasey	wild oat grass
Deschampsia atropurpurpea (Whal.) Scheele	mountain hair grass
Dicranum fuscescens Turn.	moss
Dicranum polysetum Sw.	moss
Dicranum scoparium Hedw.	moss
Dicranoweisia crispula (Hedw.) Lindb.	moss
Disporum oreganum (S. Wats.) Miller	fairybells
Draba aurea Vahl	draba
Drepanocladus uncinatus (Redw.) Warnst.	moss
Dryas drummondii Rich.	yellow mountain avens
Dryas hookeriana Juz.	white mountain avens
Dryopteris austriaca (Jaquin) Woyner	shield fern
Elymus glaucus Buckley	blue rye grass
Elymus innovatus Beal	broad-leaved rye grass
Empetrum nigrum L.	black crowberry
Epilobium angustifolium L.	fireweed
Epilobium alpinum L.	alpine fireweed
Epilobium latifolium L.	broad leaved fireweed
Equisetum arvense L.	field horsetail
Equisetum scirpoides Mx.	dwarf horsetail
Equisetum sylvaticum L.	wood horsetail
Equisetum variegatum Schleicher	variegated horsetail
Erigeron acris L.	small fleabane
Erigeron peregrinus (Pursh.) Greene	fleabane
Erythronium grandiflorum Pursch.	glacier lily
Festuca occidentalis Hooker	western fescue
Festuca ovina L.	sheep fescue
Fragaria virginiana Duch.	wild strawberry
Galium boreale L.	northern bedstraw
Galium triflorum Mx.	three-flowered snowberry
Gaultheria hispidula (L.) Muhl	creeping snowberry
Gentianella amerella L.	annual gentian
Geocaulon lividum (Richards) Fern	bastard toadflax
Geranium viscosissimum F. & M.	sticky geranium
Goodyera oblongifolia Raf.	rattlesnake plantain

Scientific Name	**Common Name**
Goodyera repens (L.) Br.	dwarf rattlesnake plantain
Gymnocarpium dryopteris (L.) New.	oak fern
Habenaria obtusata (Pursh.) Richards	one-leaved reinorchid
Habenaria unalaskensis (Sprengel) Watson	slender spire orchid
Hedysarum mackenzii Richards.	buffalo bean
Heracleum lanatum Mx.	cow parsnip
Heterocladium procurrens (Mitt.) Rau & Herv	moss
Hieracium albiflorum Hooker	white-flowered hawkweed
Homalothecium megaptilum (Sull.) Robins	moss
Hylocomium splendens (Hewd.) B.S.G.	moss
Hypnum circinale (Hook.)	moss
Hypnum subinponens Lesq.	moss
Isopterygium elegans (Brid.) Lindb	moss
Juniperus commonis Pallis	common juniper
Juniperus scopulorum Sarg.	Rocky mountain juniper
Ledum groenlandicum Oeder	labrador tea
Linnaea borealis L.	twin flower
Llistera cordata (L.) Br.	heart-leaved twayblade
Lonicera involucrata (Rich.) Banks	black twinberry
Lophocolea heterophy (Schrad.) Dumort.	liverwort
Lycopodium annotinum L.	stiff clubmoss
Lycopodium alpinum L.	alpine clubmoss
Lycopodium complantum L.	ground cedar
Menziesia ferruginea Sm.	false azalea
Mitella nuda L.	mitrewort
Mnium drummondii Bruch & Schimp	moss
Mnium spinulosum B.S.G.	moss
Moneses uniflora (L.) Gray	one-flowered wintergreen
Oplopanax horridus (Sm.) Miq.	devil's club
Orchis rotundifolia Banks	one-leaved orchid
Oryzopsis asperifolia Michx	rice grass
Osmorhiza chilensis H. & A.	sweet cicely
Parnassia fimbriata Koning	fringed grass of parnassus
Parnassia palustris L.	common grass of parnassus
Pedicularis bracteosa Bentham	bracted lousewort
Peltigera aphthosa (L.) Willd.	lichen
Peltigera canina (L.) Willd.	lichen
Peltigera polydactyla (Neck.) Hoffm.	lichen
Peltigera spp. 1	lichen
Peltigera spp. 2	lichen

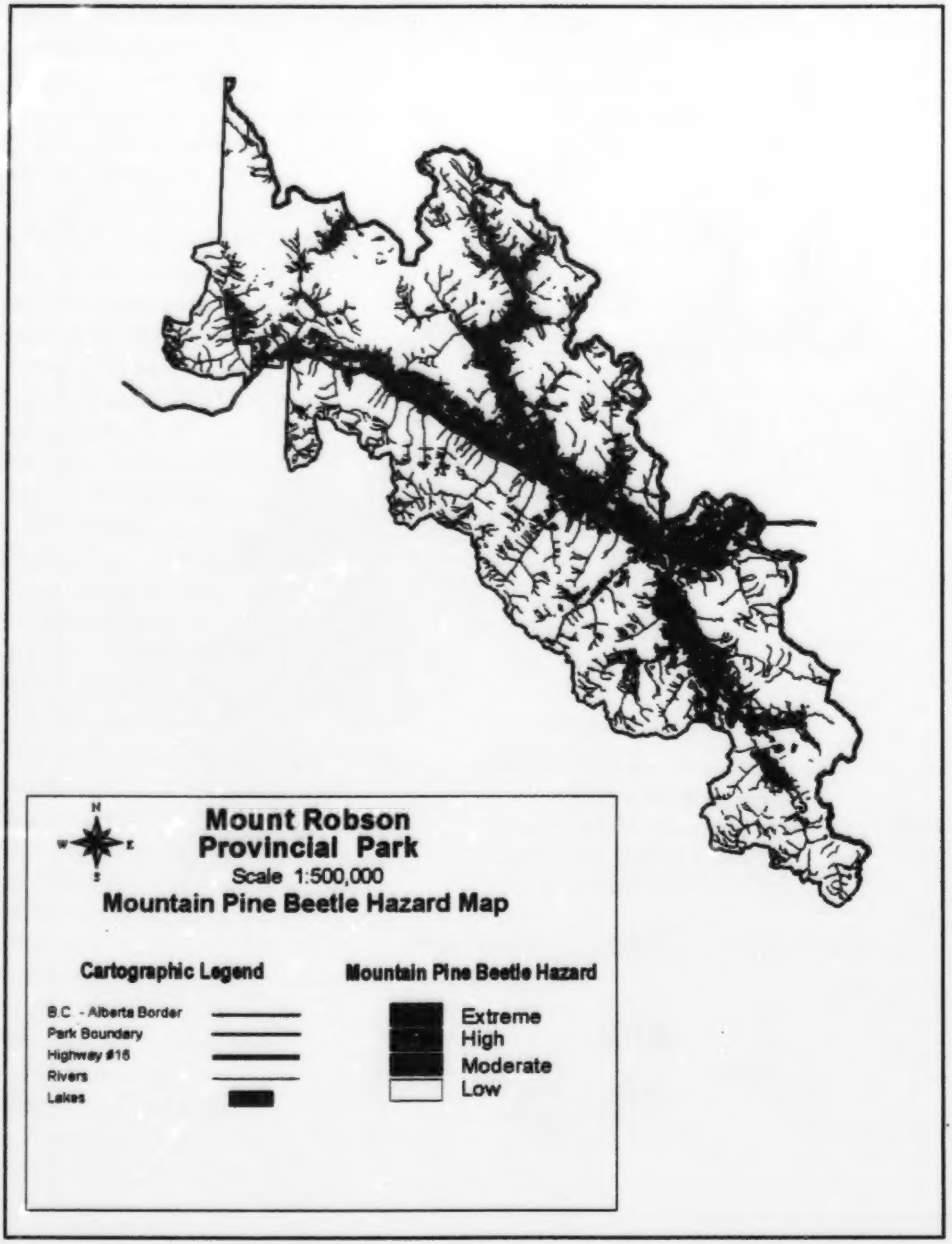
Scientific Name	Common Name
Petasites hyperboreus Rydb.	colt's foot
Phyllodoce empetriformis (Sm.) D. Don	red mountain heath
Phyllodoce glanduliflora (Hooker) Cov.	yellow mountain heath
Picea engelmannii Parry	Engelmann spruce
Pinus albicaulis Eng.	whitebark pine
Pinus contorta Douglas	lodgepole pine
Plagiochila asplenioides (L.) Dumort	liverwort
Plagiothecium spp.	moss
Pleurozium schreberi (Brid.) Mitt.	moss
Poa alpina L.	alpine bluegrass
Poa spp.	bluegrass
Polygonum viviparum L.	live-bering knotweed
Polystichum lonchitis (L.) Roth	holly fern
Polytrichum juniperinum Hewd.	moss
Polytrichum piliferum Hewd.	moss
Populus tremuloides Mx.	trembling aspen
Potentilla fruticosa L.	shrubby cinquefoil
Pseudotsuga menziessi (Mirbel) Franco	Douglas-fir
Ptilium crista-castrensis (Hewd.) De Not.	moss
Pyrola asarifolia Mx.	large wintergreen
Pyrola secunda L.	one-sided wintergreen
Pyrola virescens Schweigger	greenish-flowered wintergreen
Ranunculus eschscholtzii Schlecht	Eschscholtz's buttercup
Rhacomitrium canescens (Hedw.) Brid.	moss
Rhizomnuim glabrescens (Kindb.) Koponen	moss
Rhizomnium nudum (Williams) Koponen	moss
Rhizomnium perssonii Koponen	moss
Rhododendron albiflorum Hooker	white rhododendron
Rhytidiadelphus triquetrus (Hedw.) Warnst.	moss
Rhytidiopsis robusta (Hedw.) Broth.	moss
Ribes lacustre (Pers.) Poiret	wild gooseberry
Rosa acicularis Lindl.	wild rose
Rubus parviflorus Nutt.	thimbleberry
Rubus pedatus Sm.	trailing rubus
Rubus pubescens Raf.	rock raspberry
Rubus strigosus Michx.	wild raspberry
Salix barclayii Andersson	Barclay's willow
Salix barrattiana Hooker	Barratt's willow
Salix glauca L.	blue-green willow
Salix scouleriana Barratt	Scouler's willow

Scientific Name	**Common Name**
Salix spp.	willow
Salix vestita Purch. Var. *erecta* Anderss.	upright net-leaved willow
Sambucus racemosa L.	red-berry elder
Saxifraga bronchialis L.	saxifrage
Schizachne purpurascens (Torrey) Swallen	Swallen-false melic
Sedum lanceolatum Torrey	sharp-leaved stonecrop
Senecio pauperoulus Mx.	ragweed
Senecio pseudaureus Rybd.	ragweed
Senecio triangularis Hooker	triangle-leaved ragweed
Shepherdia canadensis (L.) Nutt.	buffalo berry
Smilacina racemosa (L.) Desf.	false spikenard
Solidago multiradiata Aiton	mountain golden rod
Sorbus sitchensis Roemer	mountain ash
Spiraea lucida Dougl. Ex. Hook.	flat top spirea
Stereocaulon spp.	lichen
Streptopus amplexifolius (L.) DC.	large twisted stalk
Streptopus roeus Mx.	pink-flowered twisted stalk
Streptopus streptopoides (Led.) Frye & Rigg.	dwarf twisted stalk
Thalictrum occidentale Gray	meadow rue
Thuja plicata D. Don	western redcedar
Tiarella trifoliata L.	three-foliate foam flower
Tiarella unifoliata Hooker	one-folliate foam flower
Timmia austriaca Hedw.	moss
Tofieldia pusilla (Mx.) Pers.	dwarf false asphodel
Trisetum spicatum (L.) Richter	spike trisetum
Trollius albiflorus (A. Gray) Salisb.	white globe flower
Tsuga heterophylla (Raf.) Sarg.	western hemlock
Vaccinium caespitosum Mx.	dwarf huckleberry
Vaccinium membranaceum Douglas	black huckleberry
Vaccinium myrtilloides Michx.	velvet-leaf blueberry
Vaccinium ovalifolium Sm.	oval-leaved blueberry
Valeriana sitchensis Bong.	valerian
Veratrum eschscholtzii Gray	false hellebore
Viburnum edule (Mx.) Raf.	high bush cranberry
Viola adunca Sm.	blue violet
Viola orbiculata Geyer	yellow violet
Viola renifolia Gray	white violet
Zygadenus elegans Pursh.	white camas

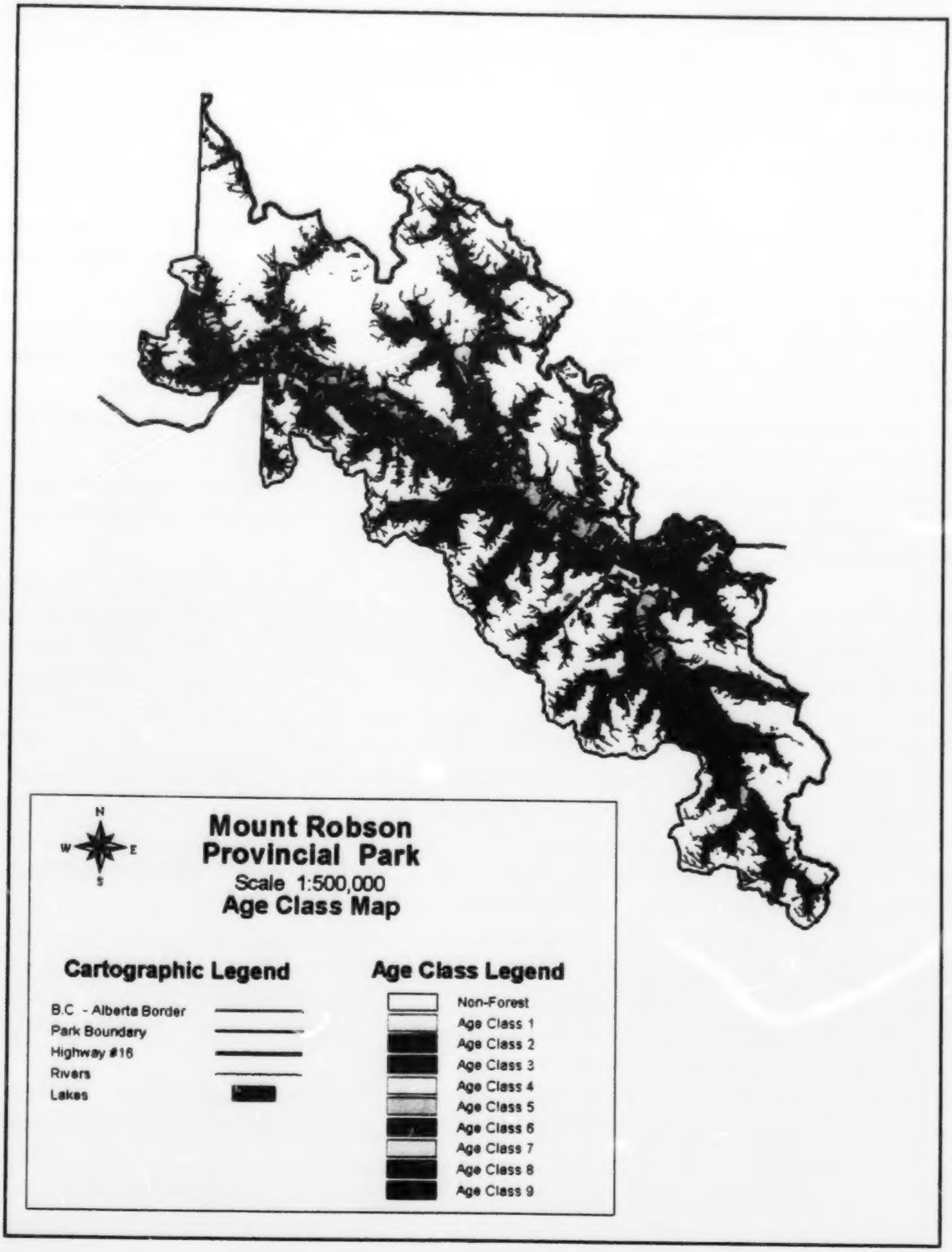
Appendix 5. Fire History Map of Mount Robson Provincial Park


N
W
E
S
Mount Robson
Provincial Park
Scale 1:500,000
Fire History Map
Cartographic Legend
B.C. - Alberta Border
Park Boundary
Highway #16
Rivers
Lakes
Predictive Fire History Legend
Year
Age Class
1959-1999
1,2
1939-1959
3
1899-1939
4,5
1879-1899
6
Not Recently Disturbed
7,8,9

Appendix 6. Mountain Pine Beetle Hazard Map of Mount Robson Provincial Park


N
W
E
S
Mount Robson
Provincial Park
Scale 1:500,000
Mountain Pine Beetle Hazard Map
Cartographic Legend
B.C. - Alberta Border
Park Boundary
Highway #16
Rivers
Lakes
Mountain Pine Beetle Hazard
Extreme
High
Moderate
Low

Appendix 7. Age Class Map of Mount Robson Provincial Park


N
W
E
S
Mount Robson Provincial Park
Scale 1:500,000
Age Class Map
Cartographic Legend
B.C - Alberta Border
Park Boundary
Highway #16
Rivers
Lakes
Age Class Legend
Non-Forest
Age Class 1
Age Class 2
Age Class 3
Age Class 4
Age Class 5
Age Class 6
Age Class 7
Age Class 8
Age Class 9

Appendix 8. Evaluation of Woodland Caribou Winter Range in Mount Robson Provincial Park (Keystone Wildlife Research 1998)

Introduction

Background and Objectives

The Mount Robson Provincial Park Ecosystem Management Plan (Oikos et al. 1996) identified woodland caribou as a key wildlife management priority. The Ecosystem Management Plan also identified four distinct ecosystem management zones with different management approaches to reflect varying natural values and objectives as well as vegetation and natural disturbance types. They included: (i) a Suppression Zone (EMZ1) where natural disturbances (fires, insects) would include a policy of full suppression; (ii) a Prescription Zone (EMZ2) where wildfires would be permitted under certain weather conditions and prescribed fires would be allowed to reduce forest health hazards; (iii) a Natural Zone (EMZ3) that allows ecosystem processes to proceed unconstrained; and (iv) a Travel Corridor (EMZ4) zone which requires active management and full suppression of all fires. The prescription fire zone (EMZ2) was further subdivided into five subzones with different management priorities for wildlife habitat management. Subzone 1 was identified as caribou summer range, subzone 2 suspected winter range and subzone 5 known caribou winter range.

To effectively implement the Ecosystem Management Plan, BC Parks (Prince George District) requested clarification and possible refinement of the caribou winter range currently identified within the Prescription Ecosystem Zone (EMZ2) and whether this fire management approach is consistent with adjacent areas in Jasper National Park. Further clarification was also required because Ecosystem Management Zone 3 (EMZ3), which occurs to the west of EMZ2, apparently contains similar caribou values according to a biophysical caribou habitat map (MELP 1993), but recommends a natural approach to ecosystem management.

Consistent with the Management Objectives and Actions outlined in the Ecosystem Management Plan to maintain woodland caribou habitat, the purpose of this evaluation was to:

- Further refine woodland caribou winter range values within the Prescription Ecosystem Management Zone (EMZ2) identified in Mount Robson Provincial Park.
- Determine the extent of winter use by caribou particularly in subzones 5 (known caribou winter range) and 2 (suspected winter range).
- Attempt to identify whether the winter range is being used by terrestrial lichen feeding caribou originating from Jasper National Park, arboreal lichen feeding caribou (i.e., mountain caribou) considered resident in B.C., or both.
- Clarify provincial fire and forest health management approaches in Alberta and British Columbia to ensure consistent management direction with respect to woodland caribou habitat.

Study Area

The EMZ6 wildlife subzone south of the Yellowhead Highway (16) extends east from the Fraser River to Jasper National Park. North of Highway 16, the subzone extends east from the Moose River to the Alberta border. The prescription zone contains four biogeoclimatic subzones including the SBSdh along the valley bottoms and travel corridor, ESSFmm2 above the SBS, ESSFmmp or parkland habitat at upper elevations and Alpine tundra (AT) above treeline.

Methods

Review of Existing Information

Existing information was reviewed including: (1) data compiled on caribou distribution and movement patterns in Jasper National Park (JNP) (Sentar 1994); (2) biophysical habitat suitability/capability mapping (MELP 1993); and (3) potentially high caribou ecosystem units identified in the Ecosystem Management Plan (Oikos et al. 1996).

BC Parks staff (Wayne Van Velzen) as well as BC Environment staff (Glen Watts, Dave King) were consulted regarding historical and recent caribou distribution and movements in British Columbia. Wes Bradford (JNP) was contacted regarding caribou surveys in Jasper National Park, Alberta.

Aerial Winter Survey

To determine the extent of caribou use (tracks, visual sightings) in subzones 5 and 2, a reconnaissance level survey was conducted using a Bell Jet Ranger (206) helicopter. The primary purpose of the winter survey was to determine if caribou were using the area and identify which, if any, habitats were being utilized (e.g., low elevation pine-lichen forests, subalpine, etc.).

The area was surveyed twice, once on January 9, 1998 and again on March 2, 1998. Although the first trip focused on subzone 5 and the second trip on subzone 2, the area was revisited immediately south of Yellowhead Lake (subzone 5) during the second trip as this area appeared to provide the most suitable habitat (presence of terrestrial lichens) for caribou during winter.

Flying conditions were good to excellent, consisting of clear sunny days with good visibility. Temperatures were -20 to -25°C during the January 9 survey and about -6 °C during the March 2 survey. Three observers were present including E. Terry (Keystone), Gail Ross and Wayne Van Velzen (BC Parks).

Snow depths were similar between survey periods (40-60 cm in open areas; 20-30 cm in forested areas) indicating the relatively dry and below normal snow pack conditions for the 1997/1998 winter. Although the snow depths were similar between periods, the snowpack in March consisted of more sugar-snow. Actual survey time consisted of approximately three hours per survey.

The aerial and ground search was concentrated on habitat areas identified as 4W (low capability) winter range from the habitat capability caribou map (MELP 1993) as well as ecosystem units tentatively identified as caribou winter range in the Ecosystem Management Plan (Oikos et al. 1996). Ecosystem units which may include suitable winter caribou habitat included: (i) Black Spruce-Terrestrial Lichen (BL) or Pine-Azalea (PA) which both occur on dry sites and support terrestrial lichens; and (ii) Subalpine fir-Labrador Tea (FT), a moist open forest which was expected to support high arboreal lichen loads.

Ungulate tracks observed from the air were identified as moose or caribou. If doubtful, tracks were investigated from the ground. Tracks were followed until pellets or some other evidence of species specific feeding sign (e.g., browsing, cratering) was encountered.

Results and Discussion

Aerial Survey

No evidence of caribou use (sign or sightings) was observed in either subzone 5 (caribou winter range) or subzone 2 (suspected winter range). However, moose tracks were frequently seen, including one observation of a cow moose in a lodgepole pine forest south of Yellowhead Lake (identified as potential caribou winter range). The lodgepole pine bench south of Yellowhead Lake is represented by the dry Lodgepole Pine-Azalea (PA) interspersed with moist Subalpine fir-Labrador Tea ecosystem units (FT). A ground check revealed this area currently supports terrestrial lichens (*Cladina* spp. *Cladonia* spp. *Stereocaulon* spp.) on dry hummocks and eskers. The ground investigation also indicated moose were foraging primarily on willows that occur in the moist draws. Although moose tracks were occasionally observed along the Fraser River in subzone 5, there was very little activity in the valley bottom and adjacent tributaries. Wolverine tracks were observed along Tonquin Creek (6700 feet elevation) and more moose sign (tracks, feeding) was observed in subalpine parkland habitat near Geike Creek (7000 feet elevation). A ground check revealed the moose were using this high elevation habitat to feed on subalpine fir (browsed heavily, 90 cm of snow) and willow. Extensive moose sign was also recorded along the lower Moose River up to Resplendent Creek. The remains of a moose kill (wolves) was also observed at the meadows along Resplendent Creek. The upper Moose River near Colonel and Upright Creeks contained only a few moose tracks.

Clarification of Caribou Mapping and Interpretations

The Mount Robson Biophysical Project (MELP 1993) provided habitat capability ratings for caribou using 1:50 000 biophysical habitat mapping. They identified about 3% (8870 ha) of the Mount Robson project area to represent potential caribou winter range. These winter range areas, however, were rated as having low capability to support caribou (4W)[1]. The majority of these low capability areas occur along the north slopes of Waddington Peak, the bench plateau area immediately south of Yellowhead Lake as well as along the valley floor of the upper Fraser River and Resplendent Creek between Razor Peak and Mount George Graham.

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[1] Wildlife habitat capability/suitability ratings are rated for winter and summer. In general, capability ratings range form 1 (very best or very high) to 6 (nil). Class 2 areas have high capability; Class 3 areas have moderate capability and Class 4 areas have low capability. Capability does not address existing conditions, rather, it refers to the potential or how good the habitat could be.

Based upon the aerial survey and ground checks of the ecosystem units we suggest the area identified as caribou winter range within EMZ2 could be redefined to encompass a smaller area and more accurately reflect caribou winter habitat. Based on our field checks, the Pine-Azalea (PA) unit was found to have more terrestrial lichen than the Black-Spruce-Lichen (BL) ecosystem. The criteria we used to generate new winter habitat boundaries included those polygons that contained at least 40% of Pine-Azalea (PA) with a component of Subalpine-fir - Labrador tea (FT) on moderate slopes. These ecosystem characteristics are concentrated on the pine bench situated to the south of Yellowhead Lake in the ESSFmm2 subzone. Although another area with similar characteristics was also identified along the Fraser River, it is relatively isolated from any other potential winter habitat and therefore of less value.

Caribou Use of Mount Robson Provincial Park

The most recent surveys of caribou in or near Mount Robson Park include The Greater Jasper Ecosystem Caribou Research Project (GJECRP) (Sentar Consultants 1994), Edmonds (1987) caribou study in west-central Alberta and Terry's (1995) review of caribou populations in the Robson Valley, British Columbia. The GJECRP indicated 4 of 19 radio-collared caribou occasionally used the lodgepole pine bench south of Yellowhead Lake during winter. These caribou were animals that wintered primarily along the Miette River and the Mount Robson/Jasper park boundary and comprised animals of the West Jasper herd. Although this indicates there has been some previous caribou use of Mount Robson Provincial Park during winter, many of the caribou observations in Mount Robson Provincial Park occur during the summer/rut season near Tonquin Creek (Sentar 1994; D. King, W. Van Velzen personal communication). Potential movement corridors include passes at Tonquin Creek and the Athabasca Pass situated at the headwaters of the Whirlpool River.

No further winter monitoring has occurred in Jasper National Park since the GJECRP study. Fall/ rut surveys have been conducted, however they have been confined to Jasper National Park (W. Bradford personal communication). Similarly, no recent information has been collected in British Columbia since the Robson Valley caribou population review (Terry 1995; L. Ingham, G Watts personal communication).

Overall, the rugged terrain and extensive alpine/glaciers of Mount Robson Provincial Park limits the winter habitat capability for caribou. Furthermore, it is unlikely that the prescription zone (EMZ2) is utilized by mountain caribou (arboreal lichen feeders) that winter in and near the Robson Valley. Previous monitoring surveys have indicated the drainages east of Kinbasket Lake receive very little use during winter by caribou and the closest concentration of caribou in British Columbia occurs south and west of the Reservoir near Foster Creek and to the north near Forgetmenot Creek.

Although there are a small number of mountain caribou that winter in the Robson Valley west of McBride, many caribou observations in the Robson Valley are summer observations of woodland caribou (terrestrial lichen feeders) that migrate from Alberta and winter in the Willmore Wilderness Area (Edmonds 1987; Edmonds and Smith 1991; Terry 1995). In addition to the small herds west of McBride, there have also been scattered reports of caribou sightings near Horsey, Small, Holmes and Chalco Mountain. In subzone 2, both winter and summer sightings of caribou have been recorded near Moose River and Resplendent Creeks (Terry 1995; Wayne Van Velzen personal communication). Although it is difficult to know with certainty where these caribou originated from, more suitable habitat exists closer to Alberta, which suggests they likely were terrestrial lichen feeding caribou from Alberta.

Fire Management Implications

Jasper National Park (JNP) is currently revising their fire management policies and Vegetation Management Guidelines (VMG) (Alan Westhaver, Parks Canada personal communication 1997). The VMG states, the overall goal of vegetation management in the Mountain District is to maintain or restore natural composition, structure and processes of vegetation representative of the Rocky Mountain and Columbia Mountain Natural Regions.

The emerging direction from the VMG is to reintroduce natural fire regimes into Jasper National Park. These will be managed in context with other values such as caribou habitat and will likely include a variety of fire management zones. Although their management strategies have not been finalized, possible prescriptions may include small prescription burns to break up the potential catastrophic fires that could occur. Historically, these ecosystem have burned, but fire suppression policies over the last 50-60 years have allowed fuel loading to build up to dangerous levels. Over the next three months, JNP will be revising and mapping fire management zones (Alan Westhaver personal communication).

Due to cool temperatures, short growing season, lack of fuel and deep snowpacks, summer habitats of caribou in Mount Robson Provincial Park are naturally less susceptible to wildfires and may not require any special management.

Management Recommendations

The review of existing information combined with the winter survey conducted here, suggests the prescription zone (EMZ2) contains relatively low winter habitat capability for caribou. Although this is generally consistent with the 4W rating (MELP 1993), changes are suggested to the extent of caribou winter range. Therefore, implementing fire management strategies over the entire prescription zone to meet caribou winter habitat requirements appears unwarranted. Instead, the majority of the EMZ2 could be managed similar to EMZ3 with little risk to caribou values. However, because the area south of Yellowhead Lake does contain a small amount of potential winter habitat for caribou in Alberta (West Jasper), we recommend this area be managed consistent with management strategies to maintain caribou winter habitat and currently under review by Jasper National Park.

Consider redefining the boundaries of Subzone 5 (Caribou Winter Range) to include only the lodgepole pine bench south of Yellowhead Lake. This will ensure the small area of potential caribou habitat receives adequate consideration should fire threaten these pine-lichen forests prematurely. The current age class distribution of this area, however, suggests fire risks are low to moderate. Depending on the management and status of winter habitat in Jasper National Park these two areas may have increasing or decreasing importance to caribou in future years.

The winter habitat identified in the upper Fraser River is currently unlikely to be used by caribou, however, if the Jasper population expands, it may have increased value in the future. It would also be more valuable to caribou if the main winter ranges in Jasper Park are damaged by fire or other catastrophies.

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Appendix 9. Polygon by Polygon Recommendations for Wildlife Habitat Management Along the Travel Corridor in Mount Robson Provincial Park

BGC Zone	Hwy Km	Species	Wildlife Capability	Polygon Labels	Area (km^2)	Distance from Highway 16 (km)	Management recommendations by polygon
SBSdh1\dh2	2-8	moose	3W	6DSs4-4TA	.5	1	Maintain cover around TA, manage DSs for cover.
				8DSd3-2AD3	1	.2-1	Increase openings by 20% in DSd, manage remaining DSd for cover, manage AD for openings.
				8LS4-2DO4	1	.5	Manage for a 60:40 mix of cover to openings.
				6DSd4-4AD4	.5	0-.2	Make this polygon as unattractive as possible.
				6DSs3-2DSd3-2ROw	6	.2-2	Maintain cover around ROW, create 20% openings in DSs, manage DSd for cover.
SBSdh1\dh2	2-8	moose	3W	5PV4-3AD4-2AS4	2	0-1	Make this polygon as unattractive as possible.
				5PV3-3AD3-2LS3			
				PV4	1	0-1	Make this polygon as unattractive as possible.
				PV3			
				6LS3-4PV2	1.5	0-1	Manage for cover.
				SM3	1	0-.5	Manage for cover.
				SM4	2	.2-1	Make this polygon as unattractive as possible
					2	.5-1	Manage for cover.
					2	1-1.5	Manage for cover.
SBSdh1\dh2	2-8	moose	2W	AD4	1	0-1	Manage for forage.
				AD3	1	0-1	Manage for forage.
				LS4	1.5	0-2	Manage for 40% openings and 60% cover.
				LS3	1	0-2	Manage for 40% openings and 60% cover.
				LS2	.5	0-2	Manage for 40% openings and 60% cover.
				SM4	1	.5-1	Make this polygon as unattractive as possible.
				8SM4-2ROc	1	0-.5	Make this polygon as unattractive as possible.
SBSdh1\dh2	2-8	deer and elk	3W	6DSs4-4TA	.5	1	Maintain cover around TA, manage DSs for cover
				6DSs3-2DSd3-2ROw	.5	.5-1	Increase openings 20% in DSs, enhance cover in DSd, maintain and enhance cover around ROW.
				8DSd3-2AD3	1	.2-1	Increase openings 20% in DSd, manage AD for openings.
				6DSd4-4AD4	.5	0-.3	Make this polygon as unattractive as possible.
				6DSs3-2DSd3-2ROw	6.0	1-2	Maintain cover around ROW, create 20% openings in DSs, manage Dsd for cover.
ICHmm	8-22	moose	1W	8SH5-2WS5	1	0-1	No treatment, old growth.
				8SH3-2WS3	.5	0-1	*Enhance existing openings in SH and if possible create 20% more openings, manage rest of SH for cover, WS no treatment.
				8SH4-2WS4	5	0-.5	

BGC Zone	Hwy Km	Species	Wildlife Capability	Polygon Labels	Area (km²)	Distance from Highway 16 (km)	Management recommendictions by polygon
ICHmm	8-22	moose	2W	BD4	1	0-.5	Manage for openings.
				BD4	.5	.5-1	Manage for openings.
				6BD3-2PS3-2RA2	1.5	0-1	*Manage RA and PS for cover, and 40% of BD for openings the rest for cover.
				6BD4-2PS4-2RA4			
				6PS4-4BD4	1	0-.5	
				7RD4-3CF			
					1	.5	Manage PS for cover and BD for openings.
				7BD3-3RD3	1.5	0-.5	Make this polygon as unattractive as possible, to keep moose out of field.
					2	0-.5	Make this polygon as unattractive as possible.
ICHmm	8-22	moose	3W	8RA4-2RD4	4	.5-2	Manage 40% of RA for food, the rest for cover, RD manage for cover.
				8RA5-2RD5	2.5	>2	No treatment, old growth.
				DDd4	1	.5-1	Manage for cover.
				DDd3	.5	.5-1	Manage for cover.
				7DDd3-3ROw	.5	.5	*Enhance cover around ROW, manage 10% of DDd for openings, the rest for cover.
				7DDd4-3ROw	1.5	0-.5	
				8RD4-2HT	2	.5-2	HT enhance cover at edges, RD mange for 60% cover 20% openings.
				5RA4-5PS4	1	.5	Manage RA for openings and PS for cover.
				5PS4-5RA4	1	1	Manage RA for openings and PS for cover.
				5PS3-5RA3	.5	1	Manage RA for openings and PS for cover.
				HM3	1	.5-1	No treatment.
				8HM4-2RD4	1	.5	Make as unattractive as possible.
				HM4	.5	.5	No treatment.
				HM3	1	.5	No treatment.
				8DDs4-2ACw	2	.2-1	Enhance cover around ACw, manage 20% of DDs for openings and the rest for cover.
SBSdh1\dh2	22-68	moose	3W	6AD4-PV4	1	0-.5	Manage for 60:40 cover and openings.
				DSs3	.5	.5-1	Manage for cover and openings 60:40.
				DSs4	1	.5-2	Manage for cover and openings 60:40.
				5LS4-3PV4-2AD4	1.5	0-1	Manage AD for openings, PV for cover, 20% of LS for openings, 30% LS for cover.
				DSs4			
				4DSd4-3ROW-3DSd3	1.5	.5-1	Manage for 60:40 cover and openings.
					1.5	1-2	Maintain cover around ROW, manage 10% of DSd3 for openings the rest of DSd3 and DSd4 for cover.
				8PV4-2LS4			
				4DSs4-4TA-2ROw	.5	0-.5	Make this polygon as unattractive as possible.

BGC Zone	Hwy Km	Species	Wildlife Capability	Polygon Labels	Area (km²)	Distance from Highway 16 (km)	Management recommendations by polygon
				8DSd3-2TA	3	.5-1	Maintain cover around TA and ROW, manage DSs
				8DSd4-2TA			for cover.
				8DSs4-2ROw	.5	0	*Maintain cover around TA, manage 20% of DSd
					.5	0	for openings the rest for cover.
				8DSd4-2ROw	.5	0	Maintain cover around ROW, manage 20% of DSs
				8DSd3-2ROw			for openings the rest for cover.
				5WS-3OW-2BT	1	0-.5	*Maintain cover around ROW, manage 20% of
				6PV4-4SH4	1	0-.5	DSd for openings the rest for cover.
				DSd4	1.25	0	Make this polygon as unattractive as possible.
				SM4	1	0	Make this polygon as unattractive as possible.
				8DSs4-2TA	1	.5	Manage for openings and cover 60:40.
					.5	.5-2	Manage for cover.
				DSd4	1	.5-3	Maintain cover around TA, manage 20% of DSs for
				8DSd4-2DSs			openings the rest for cover.
					1.5	1	Manage for openings and cover 60:40.
				6AD4-4PV4	2	0-1	Manage 20% of DSd4 for openings the rest of the
				DSs4			polygon for cover.
				8PAc4-2ROc	.5	0-.5	Make this polygon as unattractive as possible.
				4AD4-4PV4-2LS4	.5	.5-2	Manage for openings.
					.5	.5-2	Manage for cover.
					3	0-1	Manage AD for openings, PV and LS for cover.
				6DSs4-2DSd4-2ROw	3.5	0-2	*Maintain cover around ROW, manage 20% of
				6DSs3-2DSd3-2ROw	.5	2	DSs for openings the rest of DSs and DSd for
							manage AD for openings, PV and LS for cover.
				5PV3-3CF-2LS3	1	0-1	Manage LS and PV for a mix of 60:40 cover to
							openings.
				8DSd4-2DSs4			
					.5	1-1.5	Manage DSs for openings and 20% of DSd for
				8DSd4-2AWw			openings the rest for cover.
					2	1-1.5	Maintain cover around AWw, manage 20% of DSd
				DSd3			for openings the rest for cover.
				7DSd4-3AD4	.5	.5	Manage for cover.
				6PV4-4AD4	1	1-1.5	Manage AD and 10% of DSd for openings the rest
							for cover.
				LS3	.75	0	Make this polygon as unattractive as possible.
				4LS4-4AD4-2DO4	.5	1	No treatment.
				4LS3-4AD3-2DO3	1	0	*Manage the AD component for openings and the
				4LS3-4AD3-2DO3			LS and DO for cover.

BGC Zone	Hwy Km	Species	Wildlife Capability	Polygon Labels	Area (km^2)	Distance from Highway 16 (km)	Management recommendations by polygon
				5PV4-3LS4-2WS	1.5	0	
				5PV5-3LS5-2WS			
				4DO5-4LS5-2ACc	.5	0	Make this polygon as unattractive as possible.
				6LS5-4AD5			
				6DO4-4AD4	1.5	.5-1	Maintain cover around WS, manage 20% of LS for openings, PV for cover.
				8DO4-2AD4			
				6LS4-4AD4	1.5	1-2	No treatment, old growth.
					2.5	1.5-2	No treatment, old growth.
					.5	.5	No treatment, old growth.
					0-.5	.5	Manage for a 60:40 mix of cover to openings.
					0-.5	1	Manage for a 60:40 mix of cover to openings.
					3	0-1	Manage AD for openings and LS for cover.
SBSdh1\dh2	22-68	moose	2W	6LS4-4PV4	.5	0	Make this polygon as unattractive as possible.
				6DSd3-4AD3	.5	0	Manage AD for openings and Dsd for cover.
				6AD3-4DSd3	.5	0	Manage 60% of AD for openings the rest of the polygon for cover.
				5DSd3-5AD3	.5	0	Manage AD for openings and DSd for cover.
				6DSd3-4AD3	.5	0	Manage AD for openings and DSd for cover.
				8WS-2SH5	.5	0	No treatment, old growth.
				6SH5-4WS	.75	0	No treatment, old growth.
				SH4	1	0	Make this polygon as unattractive as possible.
				AD4	.5	0	Manage for openings.
				6SH5-4WS	1.5	0-.5	No treatment, old growth.
				SH4	1	.5	No treatment.
				SH5	.5	.5-1	No treatment.
SBSdh1\dh2		deer and elk	3W	5DSs4-3DSs3-2ROw	2	1-1.5	Enhance cover around ROW, manage 20% of DSs3 for openings the rest of DSs3, and DSs4 for cover.
				6DSs4-2AD3-2ROw	1	.5-1	*Enhance cover around ROW, manage AD for openings and DSs for cover
				6DSs3-2AD3-2ROw	1.5	.5-1	
SBSdh1\dh2	68-76	moose	2W	6AD4-4SH4	1	0-.5	Make this polygon as unattractive as possible.
				7AD3-3DSd4	.75	.5-1	Make this polygon as unattractive as possible.
				AD4	.5	0	Make this polygon as unattractive as possible.

BGC Zone	Hwy Km	Species	Wildlife Capability	Polygon Labels	Area (km^2)	Distance from Highway 16 (km)	Management recommendations by polygon
SBSdh1\dh2	68-76	moose	3W	6DSs3-4LS3	.5	0	Make this polygon as unattractive as possible.
				6DSs3-2AD3-2ROw	1.5	.5-1	*Maintain cover around ROW, manage AD for openings and DSs for cover.
				6DSs4-2AD3-2ROw	1	.5-1	
				5DSs4-3DSs3-2ROw	2	1-1.5	Maintain cover around ROW, manage DSs4 for cover and 20% of DSs3 for cover, the other 10% for openings.
				6PV4-4AD4	1	0-.5	Make this polygon as unattractive as possible.
				SM4	.5	0-.5	No treatment.

* recommendations are for two polygon labels.

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